DRAFT ADVISORY CIRCULAR

FLIGHT OPERATIONAL QUALITY ASSURANCE PROGRAM

FOREWORD

Because use of flight data for safety enhancement of human factors is not prevalent among U.S. airlines, non-U.S. operators were used as the study base. Therefore, the report recommends a trial program in the U.S. air carrier environment to demonstrate the FOQA methodology and related equipment. Accordingly, the draft Advisory Circular (AC) is lacking in the detailed guidance information needed for application in a U.S. environment. After completion of a presently ongoing FOQA demonstration program being jointly conducted by the FAA and interested U.S. airlines, this draft AC will be modified to provide additional details and information.

signed by AFS-2XX

CONTENTS

CHAPTER 1. FLIGHT OPERATIONAL QUALITY ASSURANCE PROGRAM (FOQA)

SECTION 1. INTRODUCTION

1. <u>PURPOSE</u>. This draft Advisory circular (AC) provides information and guidance that can be used by air carrier, certificate holders operating under Federal Aviation Regulations (FAR) Part 121 that elect to develop a FOQA program to enhance flight safety. The FOQA program is voluntary, but implementation is recommended. Other aircraft operators can also implement FOQA. The procedures and practices outlined in this AC can be applied to all flight aspects of an air carrier's operation. This guidance can also be used in an air carrier's internal evaluation program (IEP), if the carrier has elected to implement the voluntary IEP described in AC 120-59 *Air Carrier Internal Evaluation Programs.*

This AC is primarily intended for use by an operator's flight operations and flight safety departments. FOQA programs analyze data collected during flight for a pilot's self-improvement, for the improvement of airline operations and training, and for increasing the safety of the national airspace system.

Information retrieved from cockpit voice recorders is not used in the FOQA program.

The FAA encourages certificate holders to develop and implement FOQA programs as a tool for continuously monitoring and evaluating operational practices and procedures. In AC 120-59, the FAA states that "public safety is enhanced if deficiencies are identified and immediately corrected when they are discovered by the certificate holder rather than when they are discovered by the FAA." FOQA programs can provide quantitative and objective information necessary to identify deficiencies during the certificate holder’s internal audit and evaluation process. Suggested procedures for the communication of FOQA program results to the FAA are also included.

The definitions and program elements outlined in this AC are consistent with successful programs implemented by more than 25 non-U.S. airlines.

2. BACKGROUND. Section 601(b) of the Federal Aviation Act of 1958 states: "In prescribing standards, rules, and regulations, and in issuing certificates under this title, the Secretary of Transportation shall give full consideration to the duty resting upon air carriers to perform their services with the highest possible degree of safety in the public interest." In support of the public safety objective, the FAA has publicly endorsed FOQA programs to enhance training and safety programs, flight crew performance, operating efficiency, air traffic control, and aircraft and airport design.

The FOQA program is based on the premise that air carriers have prime responsibility for continuously monitoring and ensuring that their operations are safe and in compliance with their operating standards and the FAR. The FOQA program will assist certificate holders in identifying and addressing operational deficiencies and trends that are not generally detectable with other procedures. The availability of certain FOQA program data to certificating authorities, manufacturers and airport operators will contribute to improving the safety and efficiency of design and operations of air traffic control systems, aircraft and airports.

FOQA users agree that insights derived from these programs have prevented serious incidents and accidents and have led to improved operating efficiencies. Manufacturers of large jet transports have also endorsed FOQA as a means of enhancing safety by improving operating procedures and crew training and aircraft design, especially in the human-machine interface.

A FOQA program also helps to identify and correct deficiencies in flight crew training and operating procedures. Other safety objectives include development of an automated industry safety data base and improved training information based on incident analysis and indicators of the level of safety. Inter-airline sharing of FOQA trend information will support these improvements.

3. **<u>REFERENCES</u>.** The FOQA study report, *Air Carrier Voluntary Flight Operational Quality Assurance Program*, is available from the FAA Flight Standards Office and the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161, Telephone: (703) 487-4600. The FAA encourages air carriers to examine this report regardless of whether or not they implement a FOQA program. The NTIS also supplies copies of the following relevant publications:

a. AC 120-59 Air Carrier Internal Evaluation Programs;

b. Air Carrier Internal Evaluation-Model Program Guide;

c. AC 120-56 Air Carrier Voluntary Disclosure Reporting Procedures;

d. AC 120-54 Advanced Qualification Program (AQP); and,

e. AC 00-46C Aviation Safety Reporting Program (ASRP).

FAA Order 2150.3A, Compliance and Enforcement Program, provides policy information to FAA personnel on the IEP and access to FAA-mandated data recorded by digital flight data recorders (DFDR). The FOQA program is based on present-day quality assurance and Total Quality Management (TQM) principles.

SECTION 2. DEFINITIONS

4. DEFINITIONS.

a. <u>Airborne Data Acquisition</u>. This electronic data processing equipment satisfies a wide range of requirements for aircraft flight data recording. It provides acquisition and signal conditioning for a variety of aircraft parameter sensor types and performs conversions to transfer data to Digital Flight Data Recorders (DFDRs) or other devices. Several of the most common types are:

(1) Flight Data Acquisition Unit (FDAU). This type is used with the original FAA-mandated DIDRs. The FDAU was designed to accept analog data inputs per ARINC 573 design specifications.

(2) Digital Flight Data Acquisition Unit (DFDAU). This second-generation processing equipment accepts digital data from ARINC 429 digital data buses. Later versions include microprocessors that can be programmed to analyze data and generate reports. Limited solid-state storage exists in some units and they comply with ARINC 717 design specifications.

(3) Flight Data Interface Unit (FDIU). This performs functions similar to DFDAU.

(4) Digital Flight Data Acquisition Card (DFDAC). This single circuit card performs the function of the DFDAU in providing processed data to the FAA-mandated DFDR.

b. Aircraft Integrated Monitoring Systems (AIMS). This class of airborne data acquisition and management systems, of varying capabilities, provides recorded flight data on the operation and performance of the aircraft, engine and on-board systems. Data systems that are included in this definition are:

(1) Aircraft Integrated Data Systems (AIDS);

(2) Aircraft Condition Monitoring System (ACMS);

(3) Auxiliary Data Acquisition System (ADAS);

(4) Flight Data Acquisition and Management System (FDAMS); and,

(5) Aircraft Recording and Monitoring System (ARMS).

c. ARINC Communication And Reporting System (ACARS). This is an addressable digital data-link that allows two-way communication of information on an ARINC Very High Frequency (VHF) radio network. Data sent and received on the ACARS network reduces communication errors and decreases the number of required voice transmissions by flight crews, thus enabling them to focus on other duties.

d. Aviation Safety Reporting System(ASRS). ASRS is a program that is conducted by NASA for the FAA that provides for voluntary confidential reporting of safety-related aviation incidents or occurrences by involved parties and immunity for these parties under prescribed conditions.

e. Data De-identification. This refers to the removal of any elements of the recorded flight data that could be used to associate it with a particular flight, date, or flight crew.

f. Data Management Unit (DMU). This equipment performs the same functions described for the acquisition units and also allows advanced capabilities for onboard analysis, report generation, and data transfer to peripheral devices. Expanded solid state memories provide substantial storage for in-flight reports. In most cases, the DMU software programs can be changed with floppy disks.

g. Data Transcription. Data transcription is the software process that transforms the recorded data format back into synchronized frames of binary bits that are representative of the bit sequence fed originally to the recorder by the FDAU or DFDAU. Data recorded on a flight recorder are encoded generally in Harvard biphase or bipolar format. This is an analog recording of a digitally encoded data stream.

h. Data Validation. This process reviews the event report data to ensure that the report was not generated as a result of erroneous data or damaged sensors.

I. Event Levels. These are the limits that classify the degree of exceedance from the established norm into two or more severity categories.

j. Exceedance Envelope. This defines the limits that will trigger an exceedance report when assigned to a particular operational event.

k. Exceedance Plot. This event report is printed in a two-dimensional plot of the exceedance and event-related flight parameters during several minutes of flight.

l. Flight Data Analysis Programs. These software application programs are designed to process and scan selected flight data parameters and compare recorded or calculated values to predetermined norms by use of event algorithms and, when exceedances are found, generate exceedance reports for review or trending.

m. Flight Operational Quality Assurance (FOQA). FOQA is a program capable of obtaining and analyzing data recorded in flight to improve flight crew performance, air carrier training programs/operating procedures, air traffic control procedures, airport maintenance/design, and aircraft operation/design.

n. Federal Freedom of Information Act (FOIA). The federal Freedom of Information Act (FOIA) provides that all U.S. citizens and residents are entitled to request any records in possession of the executive branch of the federal government. The term "records" includes documents, papers, reports, letters, films, photographs, sound recordings and computer tapes. An object that cannot be reproduced is not considered a record in this case.

The federal FOIA covers the president's cabinet agencies, independent agencies, regulatory commissions and government-owned corporations. Congress is exempt, as are federal courts and state and local governments. However, a number of states and municipalities do have laws modeled after the federal FOIA.

o. Gatelink. This is a system under development that will allow high-speed retrieval or transfer of on-board aircraft data to ground facilities by an infrared beam. In some ground configurations, a cable may be necessary.

p. RF-Link. This system is analogous to gatelink, but relies upon radio frequency transmission within the immediate locale of the airport to transmit aircraft data to ground facilities.

q. Quick Access Recorder (QAR). This equipment is capable of recording AIMS data and has provisions for quick extraction of the data on a medium that is easily transportable. Most recent versions are called "intelligent" because their microprocessor designs provide a limited capability to manage the data. Older QARs use magnetic tape for data storage. QARs that use optical disks (OQARs) for storage have a much greater storage capacity than the tape units. Solid state recording media may also be employed. (As of the publication of this draft AC, the storage capacity of solid recorders is considerably less than that of tape or optical media, the capabilities of solid state recorders are rapidly evolving.)

SECTION 3. OVERVIEW

5. PURPOSE AND OBJECTIVES OF A FLIGHT OPERATIONAL QUALITY ASSURANCE PROGRAM. The purpose of a FOQA program is to improve flight safety by providing more information about, and greater insight into, the total flight operations environment through selective automated recording and analysis of data generated during flight operations. Analysis of data can reveal situations requiring improved operating and training procedures, equipment, and supporting infrastructure.

Current FOQA users have demonstrated that flight safety and operational efficiency are enhanced by integrating the FOQA process into their routine operations. Information derived from FOQA programs can also complement engineering and maintenance programs.

FAA-mandated DFDRs have been used to gather empirical data about flight crew performance, weather, aircraft design, engine operation and air traffic control (ATC) for use during accident investigations. One element that has been missing from this process is quantitative information about operational incidents, which occur much more frequently than accidents and are often the precursors of accidents. (The FAA is also improving the ASRS to provide more useful incident information.)

Accident statistics indicate that approximately 70 percent of worldwide hull-loss accidents involved flight crew errors. However, these errors are linked often to other accident-enabling factors that a FOQA program can discern for identification and quantification, which will reduce risks in flight operations.

The specific objectives of a FOQA program are to:

a. Collect operational flight data to identify needed improvements in training programs, the ATC system, aircraft and airport design, and to evaluate and improve the performance of flight crews;

b. Compare the collected data with established procedures and standards to identify needed improvements, and to develop exceedance information;

c. Perform trend analyses of exceedances to evaluate corrective actions and measure performance over time; and

d. Use analyzed data in formal awareness and feedback programs to enhance safety in the following areas:

   (1) Flight procedures;

   (2) Flight training procedures;

   (3) Crew performance in all phases of flight;

(4) Air traffic control procedures;

(5) Flight crew-aircraft systems interface; and

(6) Aircraft and airport design and maintenance.

6. CONCEPTUAL ELEMENTS OF A FOQA PROGRAM. Figure 1 shows the flow and processing of FOQA data recorded in flight and the air carrier organizations involved in FOQA management.

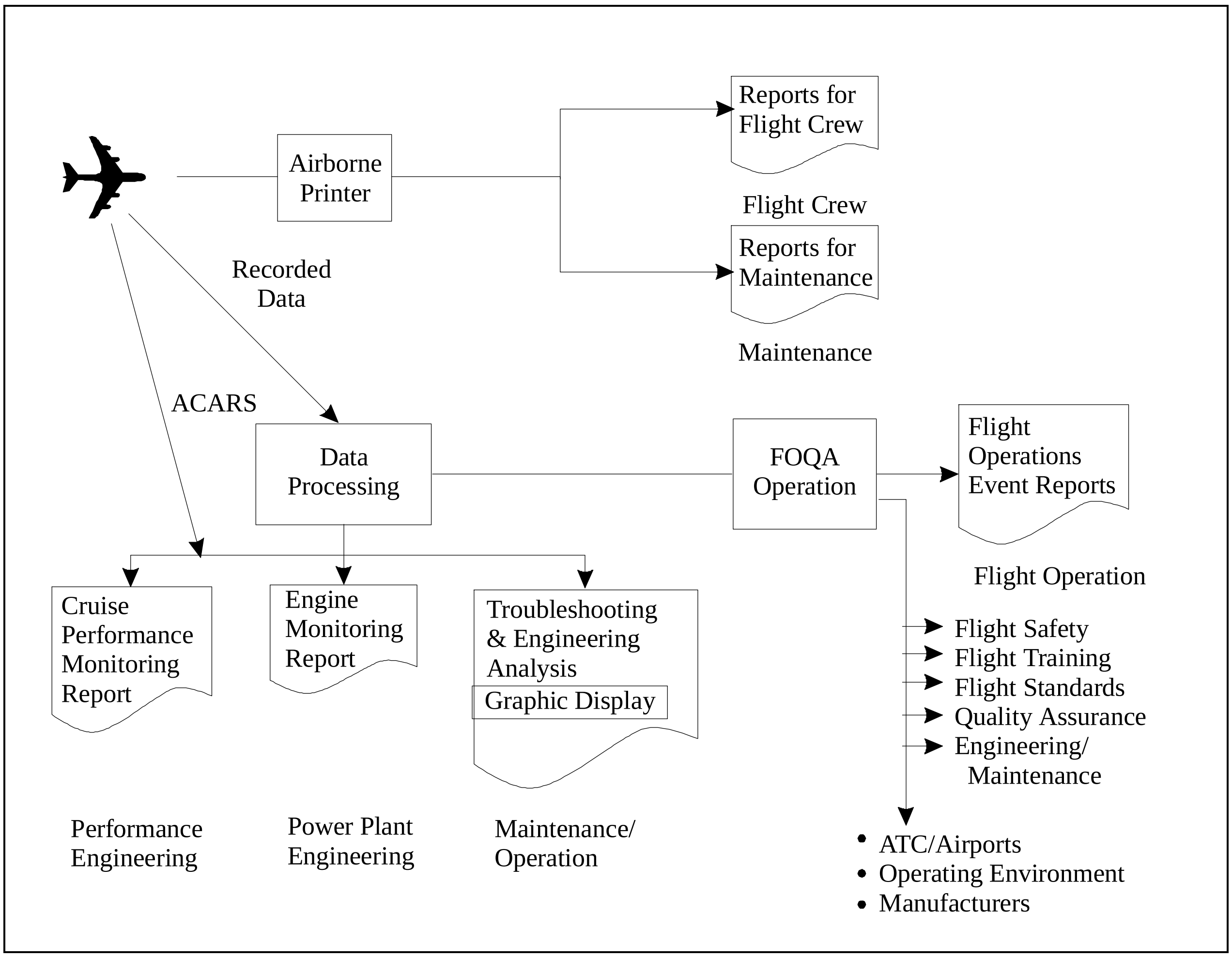


Figure 1. Concept Elements

Each element is discussed in more detail in Chapter 2.

A basic airborne system includes specific aircraft data input sources and equipment to record and store the collected data. Other airborne equipment may:

a. Process and analyze collected data;

b. Display data to pilots during flight or on the ground; and

c. Transmit data to a ground station.

A basic ground system includes the hardware/software to retrieve, process and analyze the flight data collected by the airborne system. Reports of the analyses are generated for the air carrier use. Data processing can be performed on personal computers (PCs) or more powerful computers such as mainframes.

A process system includes the necessary organization, policies, and procedures to operate the system.

7. RELATIONSHIP TO OTHER ADVISORY CIRCULARS. This AC complements AC 120-59 *Air Carrier Internal Evaluation Programs and* AC *120-56Air Carrier Voluntary Disclosure Reporting Procedures.* Information derived from FOQA programs can be included in the voluntary audits and evaluations described in AC 120-59 to determine the causes of deficiencies and suggest enhancements to operating practices. Air carriers can avoid FAA penalty actions by reporting apparent violations identified by FOQA programs by using the procedures outlined in AC 120-56.

Carriers operating under the Advanced Qualification Program (AQP) [defined in Special FAR No. 58 and AC 120-54] provide the FAA de-identified crew performance data and trend information collected during flight crew training as part of AQP validation. The FAA uses the performance information to establish group performance norms and it may also use the data to ensure that AQP changes result in a reduction of accident and incident rates.

Certificate holders operating under SFAR No. 58 may use FOQA data in addition to training data to support AQP validation.

8. PROGRAM APPLICATION. FOQA programs are applicable to and recommended for use on a voluntary basis by all FAR Part 121 operators of large jet transport aircraft. Other operators capable of monitoring FOQA parameters are encouraged to implement FOQA on a voluntary basis.

Although the FOQA concept is applicable to all Part 121 operations and aircraft types, a realistic analysis of data requirements and associated economics effectively limits the applicability and usefulness to aircraft with specific data bus configurations. These are discussed further in Chapter 2.

9. PROGRAM BENEFITS. Benefits have been achieved that include:

a. Modifications to operating procedures and training programs;

b. Revisions to ATC procedures;

c. Fuel savings resulting from use of airborne winds and temperatures in flight route planning;

d. Improved engine and aircraft performance assessment;

e. Improved weather analyses;

f. Monitoring of Ground Proximity Wanting Systems (GPWS), Traffic and Collision-Avoidance Systems (TCAS), wind shear warning systems, and autopilot systems;

g. Resurfacing of rough runways; and

h. Support of aircraft certification and research programs.

These benefits will be augmented in the future by the introduction of new aircraft, and advanced flight data systems, development of industry-standardized data bases to exchange timely information, and willingness of civil aviation authorities to use FOQA results to modernize training, air carrier internal evaluations, ATC procedures, and aircraft and airport designs.

10. MANAGEMENT. The organizational structure to manage FOQA programs should be established within a flight-operations-related department because of the safety priority associated with FOQA.

CHAPTER 2. FOQA PROGRAM PLANNING AND DESIGN

This chapter describes a general process in developing a FOQA program. Design considerations include not only the FOQA program, but also the interfacing systems that might already be on board the aircraft fleet. The design is affected by the intended uses of the data.

SECTION 1. FOQA PROGRAM ELEMENTS

11. **GENERAL**. Figure 2 shows the basic elements of a FOQA program.

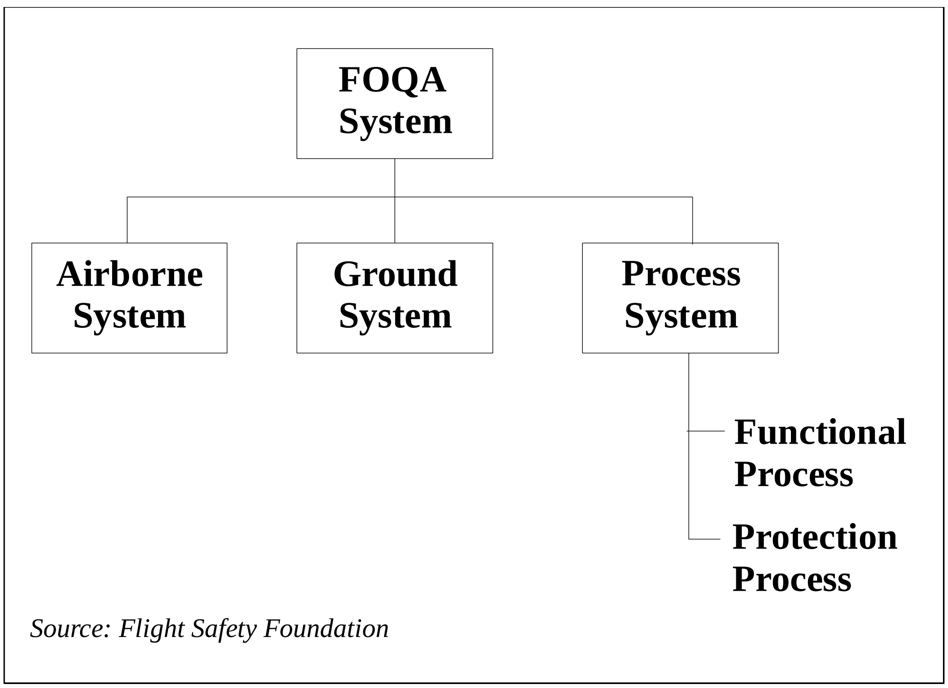


Figure 2. FOQA Program Elements

12. **FOQA PROGRAM.** The FOQA program is composed of three major elements: (1) airborne, (2) ground, and (3) process systems. The airborne and ground elements are made up of hardware and software elements. The process element supplies the methodology by which the data are produced and analyzed.

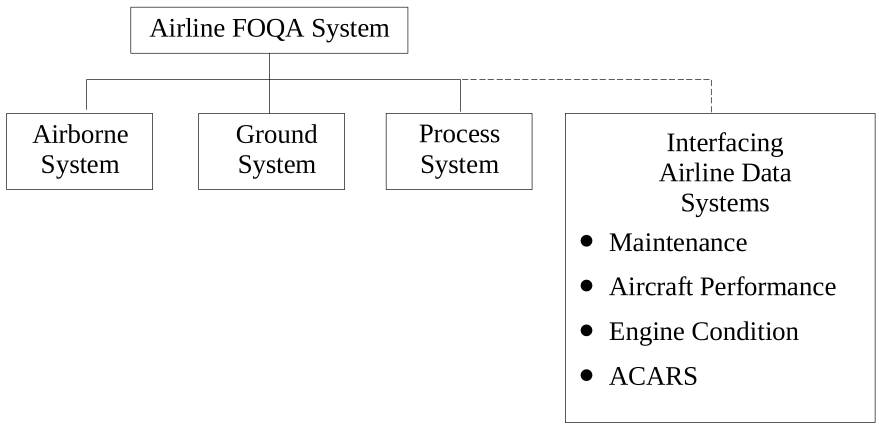
13. AIRBORNE SYSTEM. This can have a variety of parts depending on the hardware choices made by the airline, the airplane data systems provided by the manufacturer, and the systems added to the basic airplane. Regardless of the configuration, the basic purpose of the airborne hardware and software is to acquire the data and store them for processing and analysis. Some airborne equipment has a limited data processing and readout capability for such functions as selective data compression and flight crew readout.

14. GROUND SYSTEM. This processes the recorded data into required formats, operates analysis routines, and produces the required reports for analysis and action by the user organizations. Ground equipment varies widely in size and complexity. If the FOQA program is integrated into an existing large data system such as an Aircraft Condition Monitoring System (ACMS), it will probably be centrally located and use a large computer. If it is a stand-alone FOQA program, it will likely be PC-based and could have either single or multiple processing locations.

15. PROCESS SYSTEMS. This is divided into two elements: (1) the operational processes needed to make the FOQA program function and (2) the protection processes added to preclude use of the data for other than safety and operational purposes. Operating processes include those that control the data production and those that control the data evaluation, remedial actions are taken and feedback/ follow-up ensures that problems are resolved.

16. INTERFACING SYSTEMS. In most FOQA applications, particularly in advanced-technology (glass-cockpit) aircraft, the FOQA program will depend on other data systems in the airplane for input. In older, unsophisticated fleets, many measurements will continue to come from an interface with the DFDR. Modern aircraft (including those of the future) will rely on dedicated aircraft digital data buses for data inputs. In these aircraft, the airborne subsystem will select the desired data from a myriad of information on the bus. Individual parameters on these complex data buses can number in the thousands.

External interfaces are between the airline and outside organizations. Details of these interfaces are presented in Figure 3.



External Interfaces

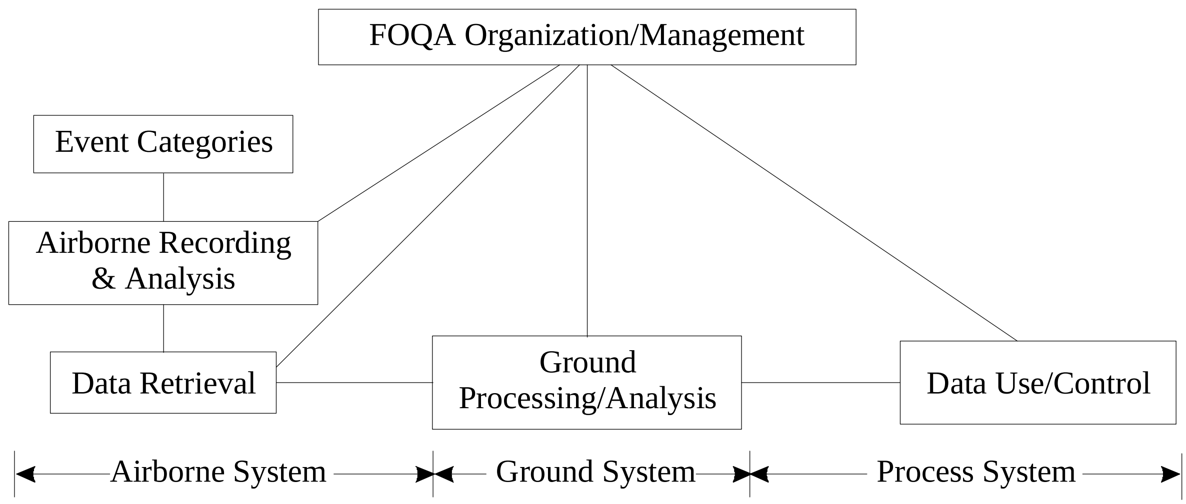
FAA	NTSB	Airframe MFGR	Engine MFGR	Other Airlines	ATC	Airport
Audit	Accident/	A/C Design	Warranty	Data	Procedures	Design
TRN/AQP Data Protection	Incident			Exchange		
Trend Data						

Source: Flight Safety Foundation

Figure 3. Airline FOQA System Outside Relationships

SECTION 2. ORGANIZATION AND MANAGEMENT

17. <u>ORGANIZATION</u>. FOQA operators should establish the organization and management of FOQA programs within a flight operations-related department. There are currently many variations of FOQA programs depending on how long the program has been established, pilot association agreements, aircraft system capabilities, airline organization, and other factors. But within these variations, there are common elements. Figure 4 is a generalized view of these common elements and shows their relationship to the FOQA processes described earlier.



Source: Flight Safety Foundation

Figure 4. Common FOQA Functional Elements

Many of the activities are conducted jointly with other routine airline activities. A number of the observed programs have ground processing and analysis facilities that serve both the maintenance and FOQA functions, and are located in a maintenance area.

However, about a third of the FOQA users have PCs dedicated to FOQA data processing. This is particularly true of operators starting with small FOQA programs. Figure 5 shows a typical management organization and its reporting relationships. There are varying degrees of participation and expertise by personnel in the management structure that are used in the event review and the feedback action processes that are required to address negative trends.

In general, FOQA activities are conducted outside routine airline operation because of the commitment to handle and treat FOQA data with a high degree of confidentiality and control, unlike other more routine operational data sources.

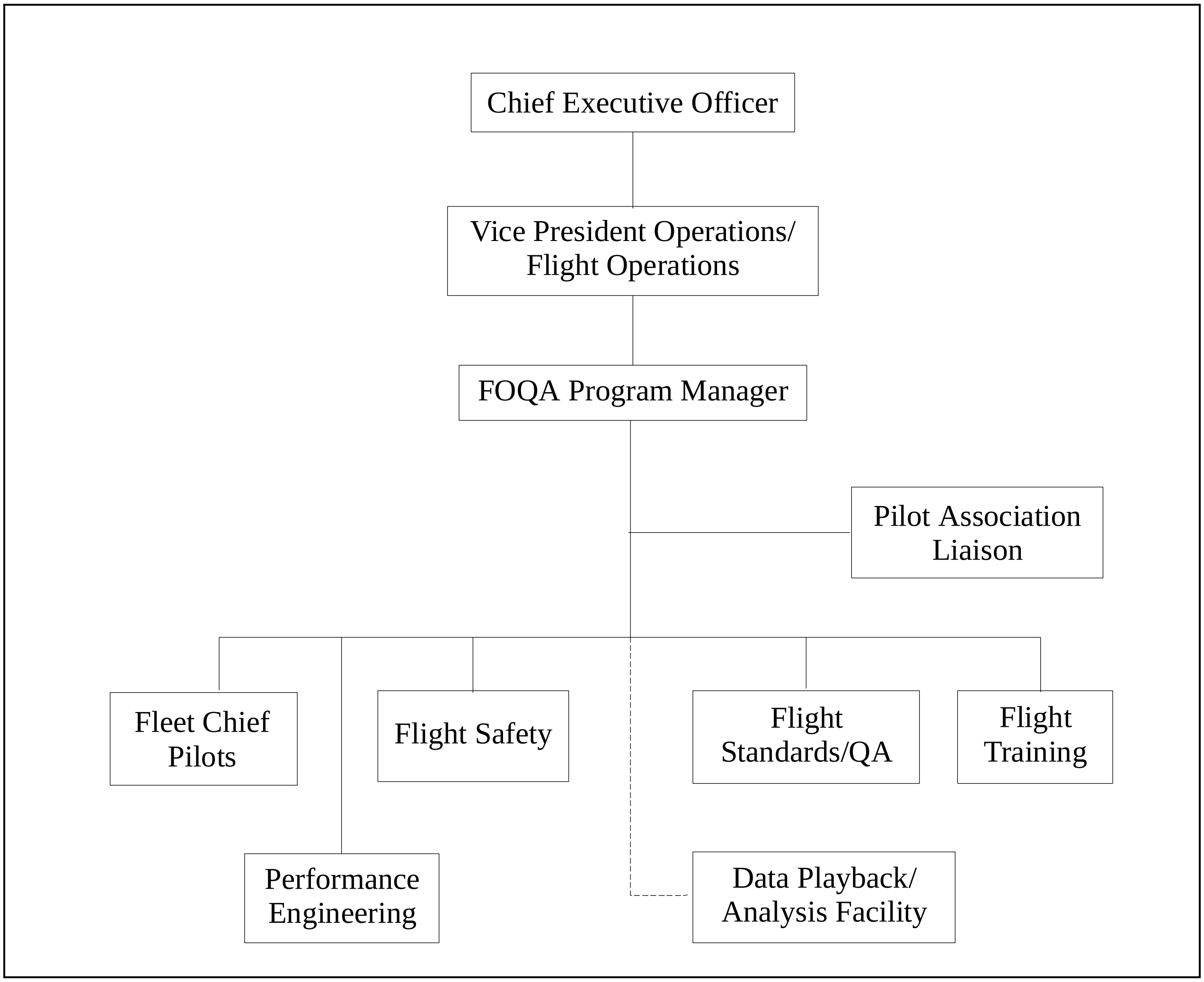


Figure 5. Typical FOQA Management Structure

The duties and responsibilities of the FOQA program manager are based almost entirely on event data use and control. Specific activities may include:

a. Administration of the program;

b. Liaison with pilot association;

c. Establishment and control of program policies and procedures;

d. Event evaluation and follow-up;

e. Feedback and coordination of safety trends;

f. Maintenance and security of trend and exceedance data bases;

g. Software maintenance and configuration control;

h. Software modifications related to event categories and trigger levels;

i. Coordination of critical operational data with maintenance and engineering; and

j. Other assigned airline responsibilities.

An informal management overlap may exist that allows FOQA managers to oversee the conduct and operation of the maintenance personnel who perform the data processing. FOQA managers who control data reduction, processing, and analysis, nevertheless strongly rely on the engineering and maintenance departments. These departments continuously need to develop and incorporate airborne system modifications, coordinate configuration changes, maintain and provide expertise on the operational aspects of the data management and recording systems, and provide answers and resolutions when data integrity is questioned.

18. DATA USE AGREEMENTS. Formal FOQA data use agreements are generally required between the airlines and flight crew associations. Agreements have existed since flight data recorders were required by legislation in the late 1950s to support goverment investigations of accidents and incidents. Expanded uses of DFDR data in FOQA programs have resulted in modifications to the language of these agreements. Even when agreements have not been formalized, there are verbal understandings and commitments concerning how and when the data would be used. In most cases, the agreements are general and focus on protection of the flight crew from use of the data for punitive action. The most common provisions of these agreements are:

a. Individual protection;

b. Data use;

c. Data access;

d. ACARS; and

e. Crew member identification.

Some of the more recent agreements are very specific and discuss how the data are processed, managed, evaluated, de-identified, and retained. Most agreements lack definitive language concerning circumstances in which a crew member would be identified or contacted. This is usually subject to a company and labor review on a case-by-case basis and always involves the union FOQA representative if a flight crew union represents the pilots.

19. <u>DATA PROTECTION AND SECURITY CONSIDERATIONS</u>. The issue of data protection and security is sensitive and focuses on data that can be identified with a particular air carrier, flight, date, or flight crew. Any use of identified data for purposes other than safety enhancement is counterproductive to achieve FOQA's goals. Restrictions placed on identified data arise from pilot and management agreements. It is just as crucial to a successful FOQA program that non-union pilots be assured of proper use of identified data. Agreements precluding any use of the data for punitive action must be honored by management and non-union and union pilots to ensure that the safety improvements provided by a FOQA program are preserved.

Management's responsibilities include the identification and investigation of operational irregularities and the modification of operations, procedures, and training when necessary. This can be accomplished only if there is an information flow from the involved flight crews that provides insight into the causal factors associated with an event. Thus, labor and management usually agree on a set of policies and procedures to control and restrict access to any data that are considered sensitive. These policies and procedures govern all processing of the data after an event has been identified. They determine when and how the data are to be used, who will have access to them and how long and in what form they are to be retained.

Confidentially, de-identification, and anonymity are terms relevant to the use of FOQA data. Confidentiality assures that only those authorized are allowed access to the FOQA data. Documented provisions outline the rules and procedures. Together, these permit the full examination of an exceedance event.

Anonymity precludes identification under any circumstances. Anonymous data are, therefore, only marginally useful. Thus, before data are de-identified, crews should have the opportunity to provide additional information that may enhance safety, when appropriate.

De-identification removes crew names, flight numbers, dates, and airline identities from the database.

A FOQA program must operate in an environment that encourages the voluntary submission of additional information as each situation may suggest. The program is characterized by the parties knowing each other and having the ability to interact with trust (pilot/management, operator/FAA, operator/manufacturer, etc.)

PROTECTION CONSIDERATIONS

Data control is accomplished mainly by restricting access to data. Other controls include locked and restricted entry to data playback and analysis facilities, passwords on analysis software applications and database files, de-identification, limited dissemination of identified reports and plots, and selection of personnel with a high degree of integrity. Airlines should coordinate the selection of key FOQA participants with their pilot associations to maintain effective working relationships.

Data de-identification must include airline, flight number, date, and flight crew. Data can be in a computer file or in a collection of detachable data strips that have been removed from the event reports. Identifying information should be retained only until the event has been analyzed and understood and should be securely stored and physically separated from the data printout or plot.

DATA SECURITY

Security relates to data that are retained beyond the period required to investigate the operational event. This period may vary to accommodate individual airline requirements and philosophies. Data may be classified in one or more of the following categories: (1) identified, (2) trended, or (3) archived. The sensitivity of this information is reduced when it cannot be identified with a particular flight, thus diminishing requirements for security.

SECTION 3. HARDWARE AND SOFTWARE SYSTEMS

This discussion of hardware and software systems details airborne and ground data systems capabilities and deficiencies.

20. AIRBORNE SYSTEM CONFIGURATIONS. FOQA programs use data provided by one of several on-board data management systems. These data management systems were known initially as Aircraft Integrated Data Systems (AIDS). They became known as Aircraft Integrated Monitoring Systems (AIMS) when their capabilities were expanded to include flight operations data and include Aircraft Condition Monitoring Systems (ACMS), Auxiliary Data Acquisition System (ADAS), and Flight Data Acquisition and Management System (FDAMS). **AIMS is used in this AC as a general reference to data management systems.**

This AC focuses on functional requirements and capabilities. It does not evaluate specific equipment.

Although the early AIMS met the basic requirements to record the data and provide for their retrieval, they were deficient in two important aspects. First, they were limited in their capability to adapt to changes in data requirements. Second, AIMS had limited onboard processing capability, thus preventing a timely alert of important exceedences. In the most basic configuration, the airborne system components interface with the FAA-mandated DFDR to derive data. Figure 6 presents an early configuration.

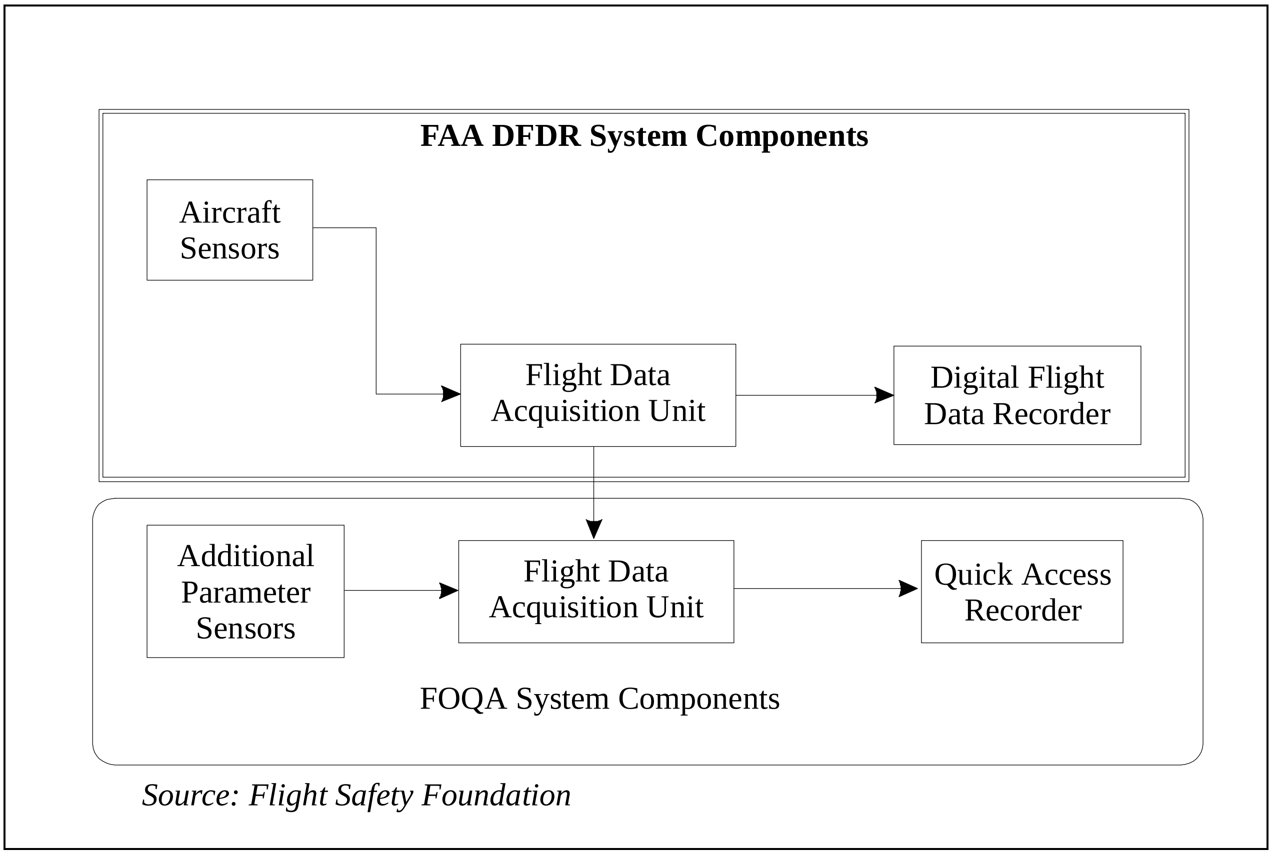


Figure 6. Elementary FOQA Airborne Recording System Configuration

The aircraft sensors in Figure 6 meet the parameters required by the relevant FAR. The additional sensors provide selected system information to evaluate the particular events chosen for review.

An FDAU acquires and processes the parameter data into a digitized data stream for recording by the DFDR.

The second FDAU provides additional capacity and maintains separation (buffering) of the FOQA data that are fed to the QAR for storage.

The most common equipment for recording FOQA data is a QAR. This unit contains magnetic tape cartridges or cassettes that can be removed and replaced quickly, and is accessible usually from the cockpit. Early QARs had little, if any, processing capability. The flight-hour capacity of these recorders varies as a function of data rates and data frame formats but falls short of airline operational requirements even under the best of circumstances. Newer optical disk QARs provide expanded storage capacity.

Airborne configurations fall into two categories, based on the applicable ARINC data system design specification. ARINC Characteristic 573 *Aircraft Integrated Data Systems* and ARINC Characteristic 717 *Flight Data Acquisition and Recording System* are the principal documents that describe common system design elements and functional capabilities.

ARINC 573 AIMS CONFIGURATIONS

This FDAU specification is applicable to the first-generation DFDRs that were installed on. L-2011, DC-10, A-300, B-737, and early B-747 aircraft.

For this generation of aircraft, the aircraft sensor signals are usually analog and require considerable signal processing by the FDAU (ARINC 573) (Figure 7 AIMS). The selected flight data parameters are generally hard-wired to the FDAU and aircraft down-time is required to reconfigure data input requirements.

The DMU part of this configuration can perform limited real-time data analysis and process and store selected exceedance reports. The unit may be programmed to perform multiple functions, such as control of the QAR and data multiplexing to increase the data rate to the QAR. Independent processors and signal conditioning permit processing the mandatory data and the aircraft system and operational data.

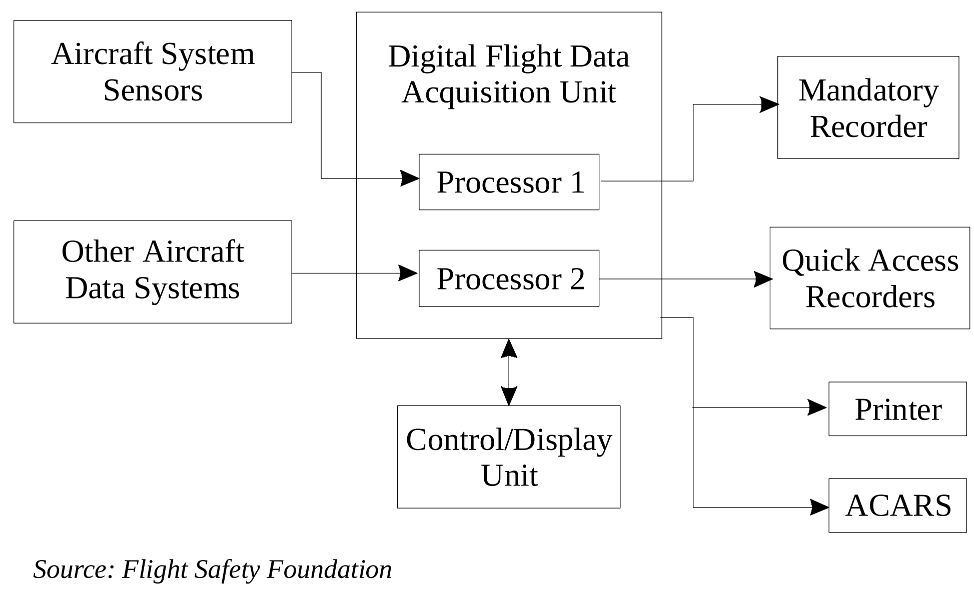


Figure 7. Aircraft Integrated Monitoring System Configuration

The Flight Data Entry Panel (FDEP), located in the cockpit, is used by the flight crew to enter flight information, such as aircraft number, trip number, date, time, and gross weight before takeoff. There is also an event button to mark occurrences that the crew may want analyzed following the flight.

The Control and Display Unit (CDU) serves as an input and output device to allow a ground operator to program the DMU options for report generation and to recover flight-generated reports and other maintenance information. The printer provides routine maintenance and engineering reports, flight data reports, and system troubleshooting queries.

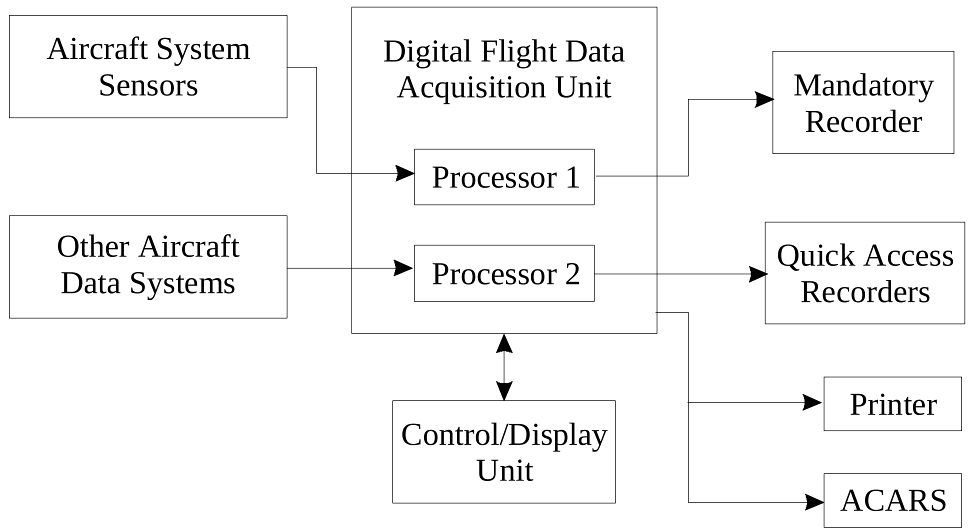
The Auxiliary Data Acquisition Unit (ADAU) is a low-capacity FDAU capable of processing special or unusual data signals.

ARINC 717 AIMS CONFIGURATIONS

Because of the dramatic increase in parameters and capabilities, these are considered second-generation data management systems. The major changes in aircraft design, including glass cockpits, greatly influenced and enhanced the AIMS concept. Avionics systems and subsystems manufacturers expanded digital data interfaces to communicate with each other and aircraft data systems according to the ARINC 429 Digital Information Transfer Standard (DITS). These digital data buses provide ready access to multiple system parameters that reflect the operation of the aircraft, engines, and their associated systems.

This FDAU specification applies to B-757, B-767, MD11, MD80, A-320, A-330, A-340, later model B-747 and B-737 aircraft, and others. Figure 8 illustrates a typical ARINC 717 AIMS configuration.

Except for the FDAU, the system components in this configuration are similar to those of the earlier generation. The FDAU has been superseded by a Digital FDAU (DFDAU), which acquires data from the aircraft's digital data buses, but the conversion processing requirements are reduced substantially. This allows the DFDAU to handle all the functions previously accomplished by the FDAU and DMU. Dual independent processors contained within the single unit maintain separation of the FAA-required and voluntary FOQA data. Microprocessor architecture provides some capability to detect, analyze, and report pre-established events. When provided with the required parameters, microprocessors also can be programmed to recognize phases of flight and then to generate reports or control the QAR based on phase-of-flight logic.



Source: Flight Safety Foundation

Figure 8. Aircraft Flight Data Acquisition and Recording System (ARINC 717 System)

The QAR flight-hour capacity problems were increased by the additional data provided by the DFDAU. Output data rate to the QAR doubled from the standard 64 words per second to 128 words per second. With associated data blocking factors, the DFDAU reduced the flight-hour capacity of the QAR. Users welcomed the improved data rate, however, it increased the frequency of cassette removals.

Parameters, exceedance reports, and other logic changes for the earlier DFDAUs frequently involve reprogramming of Programmable Read Only Memory (PROM) circuit chips. In most cases, this must be accomplished by the manufacturer because specialized equipment is required for reprogramming.

The Control and Display Unit (CDU) displays or prints maintenance or exceedance reports. Limited report format and event process changes also may be accomplished. These report the status and values of user-selected parameters for specific phases of flight. Typically, reports are generated for takeoff, climb, cruise, descent, and approach and landing.

CURRENT PRODUCTIONS SYSTEMS -- ARINC 717 AIMS

State-of-the-art AIMS is referenced by different acronyms and labels depending on the specific manufacturer or aircraft type. For example, the Boeing 747-400 system is called an Aircraft Information Management System (AIMS). The McDonnell Couglas MD-11 system is called an Auxiliary Data Acquisition System (ADAS) and that of the Airbus-330/A-340 is called an Aircraft Recording and Monitoring System (ARMS). Another manufacturer has selected the term Flight Data Acquisition and Management System (FDAMS).

Current AIMS far surpass the capabilities of the earlier configurations. The primary newer designs are functionally similar, but manufacturers' approaches to user-oriented options vary considerably. Capability has expanded because the advanced design now allows most of the individual aircraft systems to interface in the common language of the ARINC 429 Digital Information Transfer Standard (DITS). Continued advances in computer memory capacity, processors and system designs also have contributed to the improvement of earlier ARINC 717 AIMS.

These new designs (Figure 9) optimize the realtionships and efficiencies of multiple systems that cross-utilize information from a number of other systems to control their own operational modes and responses. These interfaces have always been necessary, but the required information was not generally available from a centralized source and, in many cases was generated redundantly within individual systems. The DITS concept has grown and many of these systems now are identified as data management systems and interface through their digital data buses with the aircraft. Among the more familiar systems are the Flight Management Computer (FMC), ACARS, Fuel-quantity Indicator (FQI), Air-data Computer (ADC), and Engine Indication and Crew-alerting System (EICAS).

The number of DITS data buses for a particular aircraft depends on the systems installed, but they typically range from 40 to 50 and they can provide 3,000 to 4,000 parameters for AIMS.

The AIMS do not use all the parameters available at any given time, and the FOQA programs use a subset of the AIMS selections.

This DMU performs all of the functions previously described and provides additional advanced on-board processing and expanded operator programming flexibility. Acquiring, analyzing and sorting of aircraft systems information and distributing of the results to user-selected devices remain primary functions.

The unit acquires selected parameters from the multiple data sources, evaluates the data based on user-defined requirements, detects predefined event conditions, and stores the selected event information within the DMU or QAR (or transmits it to the ground via ACARS). The information may be recorded in American Standard Code for Information Interchange (ASCII) format for direct generation of post-flight reports or as raw flight data records. The DMU allows real-time retrieval of selected data on the cockpit printer or post-flight retrieval through the MCDU.

A user first selects the operational events and the associated parameters to be monitored. These requirements are programmed on a ground data processing station, using software provided by the system supplier, and stored on a floppy disk. The floppy disk information is programmed onto the DMU disk drive. The floppy may be used to upload software modifications to the DMU or to download flight reports stored in the solid state memory. These reports provide information on multiple parameters relevant to the event recorded.

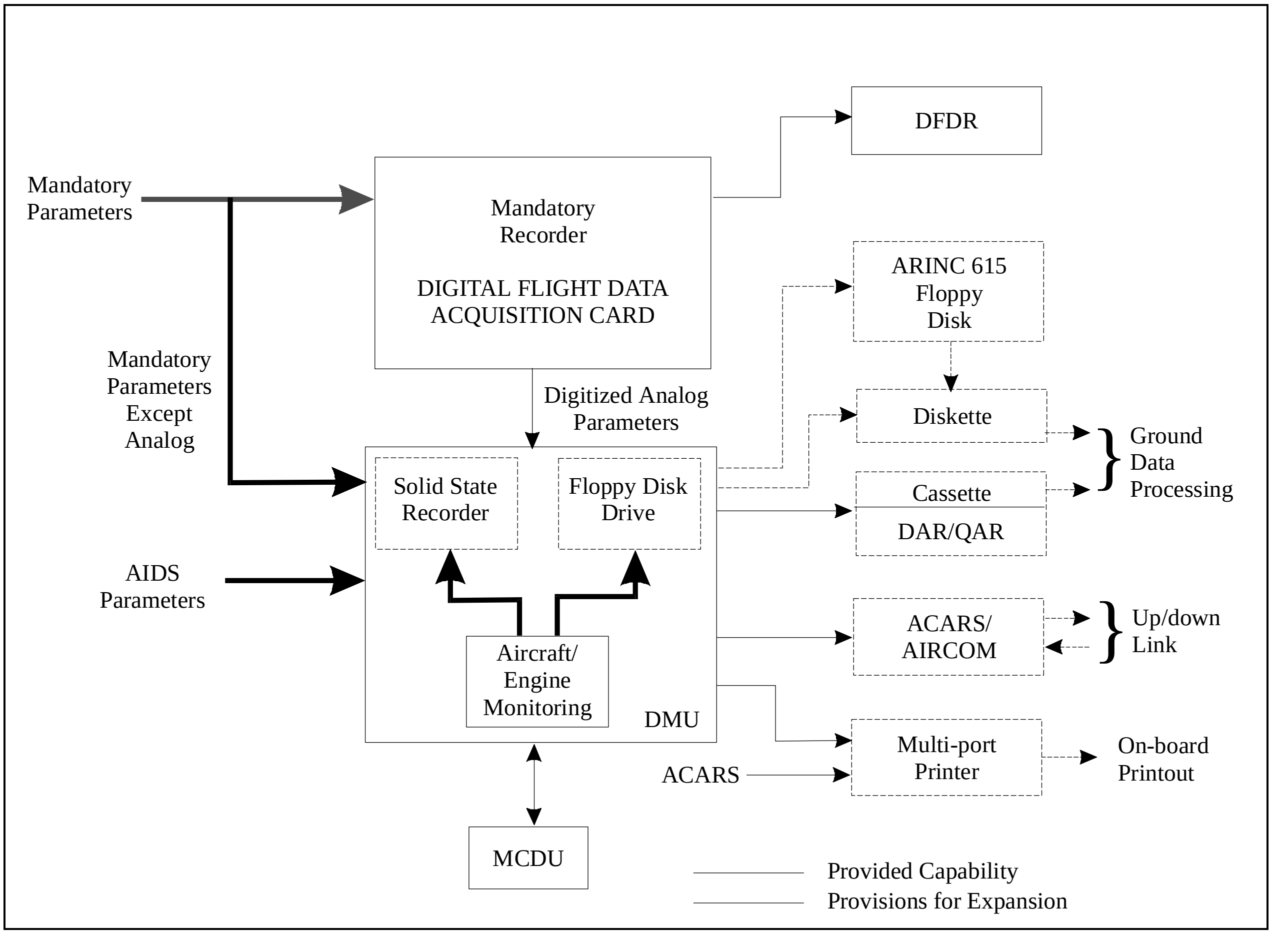


Figure 9. State-of-the-art AIMS System Configuration

Typical report options that are available to users include:

a. Takeoff performance;

b. Climb performance;

c. Flight analysis;

d. Turbulence;

e. Engine condition monitoring;

f. Cruise performance;

g. Landing;

h. Autoland; and

i. Flight summary.

These are not considered FOQA reports and mostly involve engine and aircraft systems information used by the airlines for maintenance. Many exceedance reports also would be generated if a programmed maintenance parameter limitation was exceeded. For example, engine pressure ratio (EPR), exhaust gas temperature (EGT), engine overspeed, and vertical acceleration are all examples of paramters with operational limitations that trigger a maintenance action report. Typically, 50 to 60 routine reports are set up to meet user needs and, for some systems, as many as 100 exceedance algorithms may be established.

Some systems can be temporarily reprogrammed with additional parameters for special trending or troubleshooting. This is useful for investigation of system irregularities that occur only during flight.

Data compression within the DMU has increased QAR recording capacity. Data compression requires complex mathematical processing of the variations in a parameter to reduce the data that must be recorded. For example, a parameter that remains stable for several hours, such as altitude, could be recorded as two data points and an intervening time, thus reducing significantly the amount of tape that would be required to record this one parameter for the several-hour period.

Figure 10 illustrates the potential data storage savings for an average 12-hour flight using one manufacturer's data compression method.

FLIGHT DATA COMPRESSION

A. Typical 12 Hour Flight, Non-Compressed

MODE	TIME (MIN)	RATIO	KBYTES
GRD	12	1 = 1	278
TKO	26	1 = 1	602
CRZ	635	1 = 1	14707
LAND	35	1 = 1	811
GRD	12	1 = 1	278
TOTAL	720		16676

B. Same flight Using an Average Comp. Ratio of 23 = 1

MODE	TIME (MIN)	RATIO	KBYTES
GRD	12	5 = 1	55.6
TKO	26	2.5 = 1	240.8
CRZ	635	300 = 1	49.0
LAND	35	2.5 = 1	324.4
GRD	12	5 = 1	55.6
TOTAL	720		725.4

Figure 10. Flight Data Compression

A number of data compression techniques have been evaluated for applicability to QAR capacity problems, but there is not total acceptance of them in the airline community. At issue, is the capability of these compression techniques to reproduce accurately the original time history for the compressed data parameters. Bit errors may be introduced when the data are decompressed; this may influence the integrity of the data.

The value for expanded airborne analysis of FOQA data is evident. This does not reduce the need for the QAR because the DMU memory capacity may be insufficient for FOQA needs. Using these systems for FOQA is still relatively new, and many are not programmed fully to provide the necessary information. For these reasons, the practical application is to use the QAR with some form of intermittent recording.

21. **DATA EVENT CATEGORIES.** The term "event category" refers to the classification of an occurrence. Event categories are operational conditions selected for monitoring and review. These conditions include a broad range of aircraft and engine system characteristics such as system and mode status, performance limitations, flight control system inputs and responses, rates of change, and relative time of event duration.

An event category, for example, could be "rate of descent on approach." Typically, several subevents would be defined within this category and would become progressively less tolerant of deviations as the aircraft descends to the ground. Some events are aircraft-specific because they are only applicable on certain aircraft, or they may be associated with a unique flight control or flight management system.

In maintenance, the selection of events focuses on system information related to maintenance reliability, manufacturers' warranties, aircraft and engine performance documentation for operational usage compliance [e.g., Extended Twin-Engine Operations (ETOPS) and autoland, and systems troubleshooting.

Most of the maintenance-oriented conditions are programmed for documentation purposes and not to record only an exceedance of a level to predetermined threshold value. Many cases are recorded to periodically generate a formatted report. There are important exceptions, and some critical parameters are monitored constantly for exceedance awareness, particularly engine conditions that reflect aircraft structural integrity.

In contrast, monitoring flight operations variables focuses almost totally on situational exceedances that vary by phase of flight. The primary concern is operational excursions of the aircraft and flight control systems outside standard operating procedures. Most of these require the sensing of multiple parameters, although the exceedance trigger is generally a single parameter. Some variables are simply the operating limitations of the aircraft, but most relate to the specific airline's training and operating policies and procedures.

Event categories are developed by analyzing safety issues in accidents and incidents and postulating the exceedance categories needed to identify these safety issues in an operating fleet. Current FOQA event categories have evolved from those identified by the earliest FOQA users. Modifications and expansions were incorporated by subsequent users to meet their needs. The events adopted by most users parallel standard training and flight-check syllabuses. However, generating practical event envelope limits has required appreciable trial and error in the collection of empirical flight data. Some more experienced users continue to adjust thresholds on some parameters.

Appendix A contains event categories tracked by existing programs. Categories common to at least 50 percent of the FOQA users surveyed are highlighted. Many other events are monitored for maintenance. While event categories are relatively consistent across a user’s fleet, not all event categories are monitored by every user. Appendix B lists event categories that can be monitored with state-of-the-art systems.

22. **PARAMETERS AND EXCEEDANCE LEVELS**. A parameter is a measurable variable that supplies information about the status of a system or subsystem. As an example of the relationship of parameters to events, consider an event category called “excessive pitch rate on takeoff rotation.” On older aircraft, pitch rate data are not available directly and must be derived by monitoring pitch-attitude variations. Also, the air-ground sensor (squat switch) data are needed to determine when the aircraft leaves the ground. In this case, data from three parameters (pitch-attitude, time, and air-ground sensor) would be required to define a single event.

Users have limits in selecting an ideal set of variables to monitor. The number and types available for a particular aircraft are based on:

a. FAA mandatory DFDR parameters;

b. Parameters provided by the aircraft manufacturer as part of the basic system configuration;

c. Parameters selected as change-request options on new aircraft purchases; and

d. User's fleet modifications.

The FAA-required DFDR data requires a specific set of parameters with specific sample rates and accuracies. These parameters are cross-utilized by distinct data acquisition units that separate the FAA-required data from voluntary FOQA data.

The availability of critical parameter signals influences how specific aircraft can be used in a FOQA program. Most current users selected Data Acquisition/Management Systems with extended parameter wiring at the time of aircraft purchase. Changes to add wiring or sensors are costly and time consuming.

Appendix C identifies the parameters that are used typically for the event categories common to at least 50 percent of non-U.S. FOQA users. Appendix D identifies parameters that might support a model, full-scope FOQA program. Such a program does not exist.

23. RETRIEVAL EQUIPMENT AND OPTIONS. Although there are several options for removal of recorded data from the aircraft, there are limited options for retrieving FOQA data. Data can be retrieved through QAR magnetic tape cassette, optical disk, floppy disk, data loader, printer, CRT display and data link. Because of the earlier availability of tape systems and the ease of removing data from them, many current FOQA operators use tape-type QARs. Spares can be maintained on board aircraft to facilitate data cassette exchanges at line stations when necessary.

There are no special equipment requirements for manual removal of a cassette, but there is a requirement in the ground system for a Data Recovery Unit (DRU), which serves as a data input reader when it is interfaced with the ground playback system. These units usually can be used with PCs and are supplied by the QAR manufacturers.

24. <u>GROUND PLAYBACK EQUIPMENT CONFIGURATIONS</u>. Ground data playback equipment (Figure 11) transforms the raw digital flight records into usable form for review and trending. This equipment is usually capable of handling a variety of recorded data formats and recorder types. Equipment variations are extensive and will be addressed in a general overview of common functional requirements.

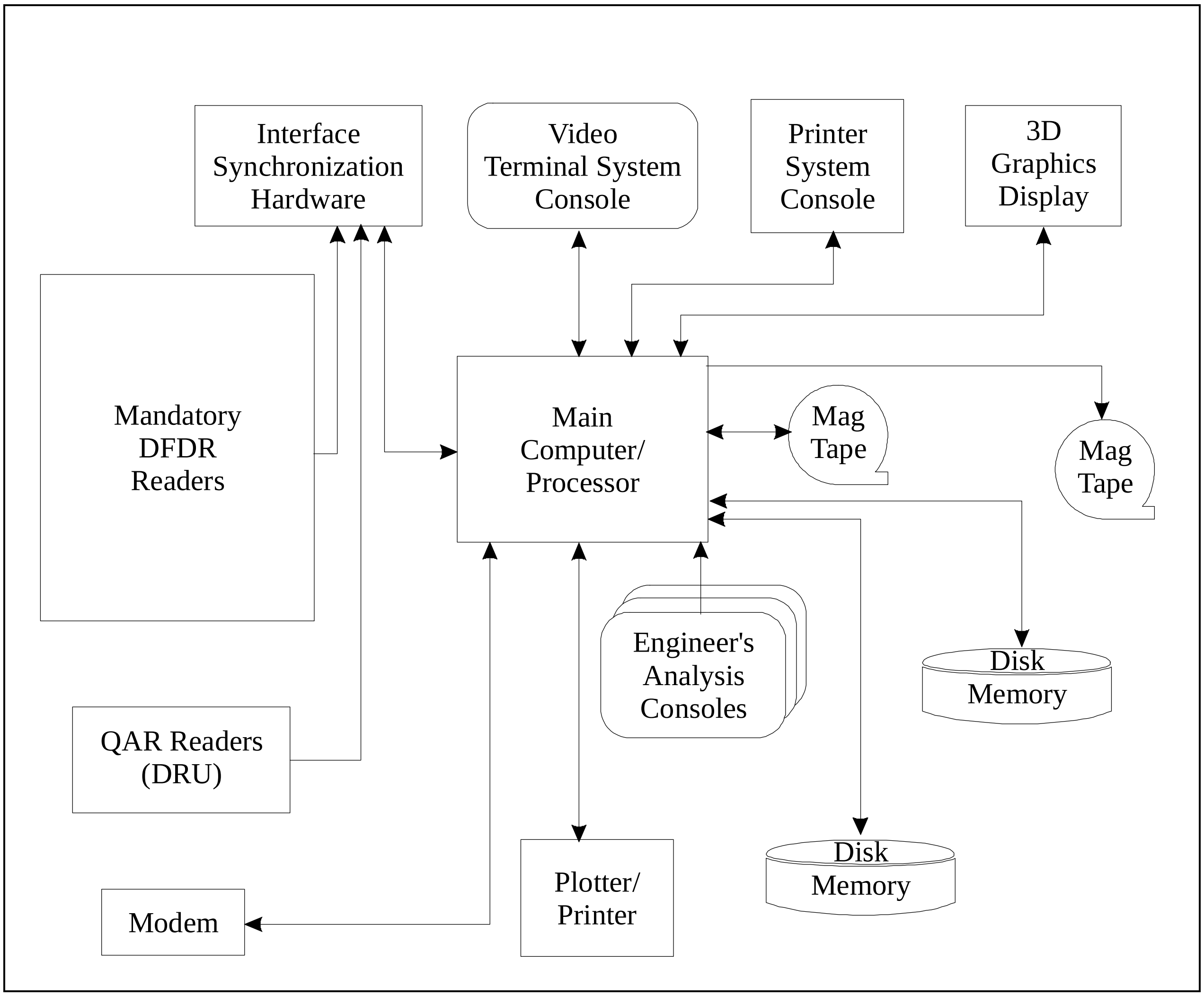


Figure 11. Typical Mainframe Data Playback Facility Equipment

The playback equipment to process FOQA data was developed initially by the DFDR and FDAU manufacturers. The original equipment used mainframe computers and PCs, but current technology allows PC-based processing and analysis.

Basic functions of the playback facility equipment are similar, regardless of specific devices selected. Data readers/recovery units read and transfer the data from the recorded medium; computer processors and storage devices receive, reformat, and store the data; and dedicated processors programmed with software applications transcribe and analyze flight information. Data storage is accomplished with magnetic tape, floppy disks, optical disks, hard drives, and solid state memory. Peripheral output devices include printers, plotters, strip chart recorders, and CRT displays. The restrictions on the handling of FOQA data influence the organization and operation of these facilities and influence the equipment selection.

Loading cassete tapes is manually labor-intensive with a large volume of tapes. In addition, constant monitoring is necessary to determine when to insert a new cassette. To reduce this burden, two or three tape readers in parallel allow simultaneous loading and unloading. However, this is a costly solution. A robotic arm may perform tape loading into several continuously operating units.

Several companies produce equipment for FOQA systems, and playback services are available to FOQA users. An example of a PC-based system is shown in Figure 12. PCs may be networked to expand the system capacity.

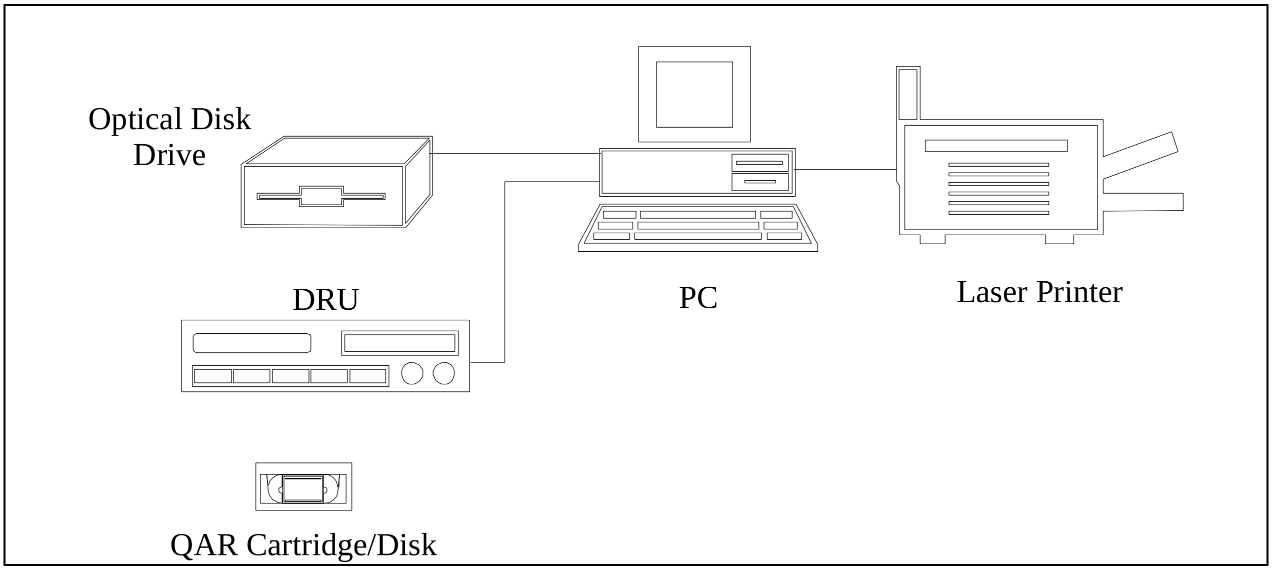
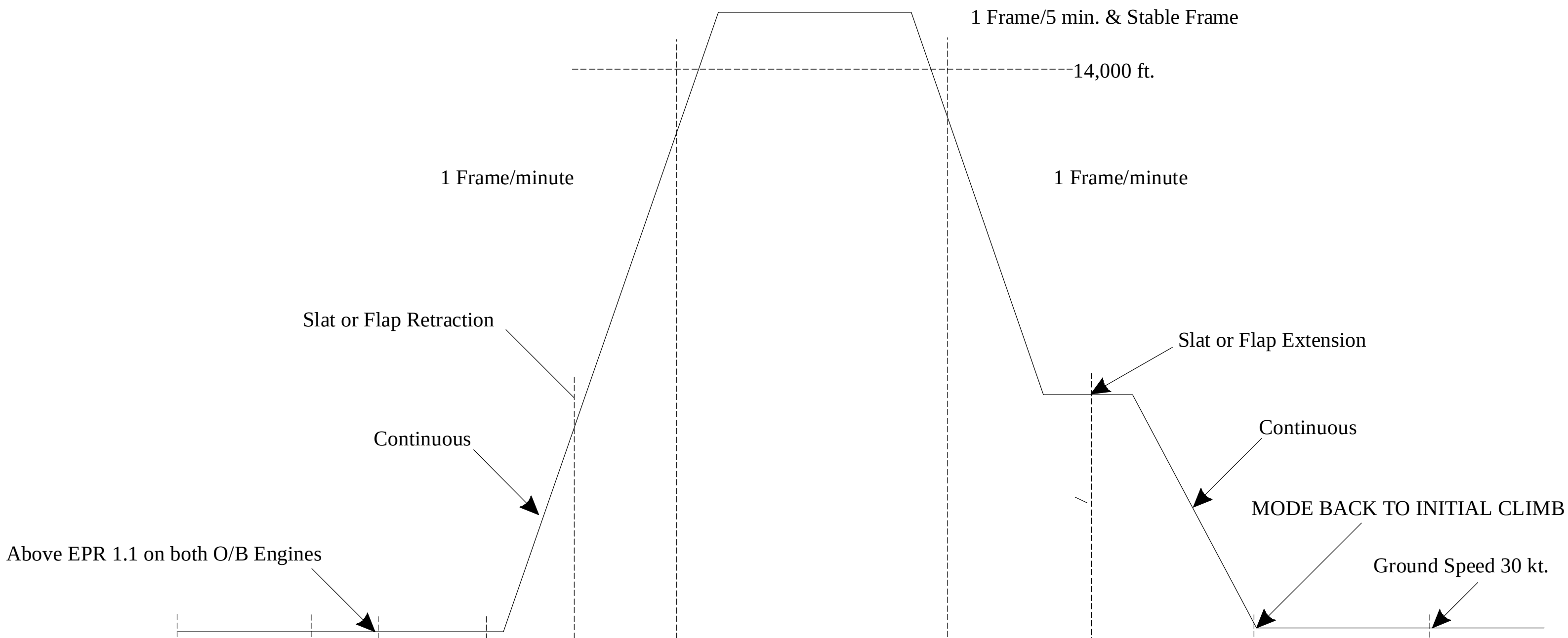


Figure 12. PC-based System

SECTION 4. OPERATING PROCESSES

25. **<u>DATA COLLECTION AND RETRIEVAL</u>**. There are two basic approaches to recording FOQA data. Both have merit. One method is to record raw data in flight for the selected parameters and to process the data using a ground replay station for event exceedance analysis. This results in considerable data mostly about routine operations. The second method is to perform real-time in-flight analysis of the events and record data only when an exceedance occurs. This has the advantage of reducing substantially the data that must be processed and reviewed on the ground, but has the disadvantage of losing expanded pre-event and post-event information that might be useful for complete understanding of some events.

Raw-data recording requires most users to use data compression or intermittent recording because of limited QAR capacity. This is programmed generally as a function of the phase of flight. Full recording is common for takeoff, initial climb, approach and landing; intermittent recordings are made during stable flight. Figure 13 illustrates this method.



Flight Mode	PRE-FLT PF	ENG. START ES	TAXI TA	TAKEOFF TO	INITIAL CLIMB IC	CLIMB CL	ENROUTE ER	DESCENT DS	APPROACH AP	LAND OR GA LD, GA	TAXI TA
AIDS Recording	I	I	I	C	C	I	I	I	C	C	I
DFDR Recording			←				C				→

C - Continuous Recording
I - Intermittent Recording

Figure 13. Typical Phase of Flight Recording Cycle

The in-flight recording and analysis requires on-board equipment that will allow the user-selected events and event limits to be programmed and contained within the airborne system. Such capacity is found only in state-of-the-art systems.

In operation, the full set of programmed parameters is continuously scanned, in real time, and the data are passed to a short-term buffer memory in the DMU for temporary storage. During scanning, the parameters are evaluated for event exceedances. If an event is triggered, a portion of the stored pre-event parameter data is recorded, along with the actual event data and some post-event data. The amount of recorded pre- and post-event data is variable and can be programmed to be as much as plus or minus three minutes from the exceedance time. These are referred to as event snapshots because the data provide only a short, bracketed view of the event. Most users prefer full in-flight recording and ground analysis in addition to event shapshots to insure that all of the historical data are available for later detailed analysis.

Routine retrieval of data from the aircraft is accomplished by removal/replacement of a QAR cassette. This procedure is usually conducted by maintenance personnel at the user's home base.

The cassettes must be removed daily because they hold a limited amount of data; otherwise, previously recorded data could be overwritten with new data. There is also a need to review and evaluate data in a timely manner for certain types of events. Spare cassettes are stocked on board the aircraft or at line stations for changes.

Real-time downloading of flight systems information by ACARS is a programmable option, but this capability does not currently include FOQA data. There is concern about unauthorized interception of radio messages. ARINC transmission of large volumes of data is also as expensive.

Some FOQA users have installed cockpit printers for maintenance purposes and these also allow the flight crew to print selected FOQA parameters or reports, either in real-time or following the flight. The data are locked shortly after engine shutdown and cannot be reviewed by maintenance personnel or crew members. However, the recorded flight data are still retained on QAR tape and are subject to routine event review.

Transport of FOQA data from the aircraft to the ground playback facility can be by ground transportation, company mail, or high-speed data transmission. Two computers can control the data communications using special software for file handling and interfacing with the FOQA playback equipment. The tapes are transcribed before being transmitted, and they are received in a format compatible with the FOQA software.

26. **DATA REDUCTION AND ANALYSIS**. Data reduction involves processes required to convert the data into a form for review. The type and degree of ground processing depends on the medium and format in which the data have been recorded. Only ASCII formatted data can be used without reformatting through software processes.

For flight data collected in raw form on a QAR, it is necessary first to transcribe the information into framed binary data and then to use a software application with appropriate algorithms to convert the binary word data to system-related units and identify exceedances from preset limits.

Transcription transforms the recorded data format into a binary bitstream that is reformatted and synchronized to the original FDAU or DMU data structure. This processing is typically accomplished at 100 to 150 times the original recorded speed and requires 20 to 30 minutes to transcribe a full cassette. The transcribed file is stored on magnetic tape, optical disk, floppy disk, or some other medium.

The transcribed file is analyzed by software applications, which apply conversion algorithms to the appropriate binary data words to produce engineering unit (parameter) values. These parameter values are then compared to event limits for exceedance evaluation. Although this involves a complex series of data manipulations, these processes are transparent to the user because they are performed internally in menu-driven application programs.

The software applications are purchased, usually from the equipment manufacturers, but in a few instances users have developed customized applications. In either case, these programs offer a variety of procedures that can be installed and customized to user needs.

Most FOQA users set up the software to scan automatically the transcribed data for event exceedances and other programmed data that were generated during the flights. This analysis could require 30 to 40 minutes, depending on the efficiency of the software and the processing power of the playback computer. A full cassette may contain from 10 to 40 flight hours of data depending on the data frame size and the cassette type.

Event reports are automatically generated as the transcription files are scanned. Scanning may be accomplished overnight, while the facilities are unattended. The format of the event reports can be a blocked listing of pertinent flight information or a flight profile reproduction of selected event-related parameters. The posted information will generally include flight number, date, aircraft tail number, flight origination and destination, time of event, and category of event.

In addition to data processing and generation of event reports, software analysis applications must perform other functions. Required modules include maintaining aircraft parameter data frame tables, event algorithm tables, and revision numbers of software configuration. Optional modules include historical data base or spreadsheet files containing cassette serial numbers (S/Ns) with associated dates, data errors, last installed QAR S/N, daily processing activity log containing cassette S/Ns, the number of events generated by event category, and the relative track location on the QAR. There is also an automated trending data base with appropriate filtering and reasonableness checks.

Options for data display include flight profile plots, engineering unit listings, and multiple parameter x-y graphs. Graphic cockpit symbology, color three-dimensional (3-D) flight simulation may be the most effective method to communicate flight path and profile information for pilot feedback and training.

27. <u>EXCEEDANCE AND EVENT TREND ASSESSMENT</u>. Figure 14 illustrates the various elements of exceedance and event assessment found in the study. Each user should develop related procedures that follow organizational structure and management requirements. The most important element is strict adherence to established review and action procedures. Committee participation in this review must include flight crew representation.

The FOQA manager should review daily the event reports generated from the previous day's processing operation. In most instances, only the more serious alert-level event reports would be generated as full reports. Most of the events will fall into a less significant category and will be fed automatically to the trending data base. It may be preferable to print only special category events accompanied by tabular event listing of peak parameter values for all other types.

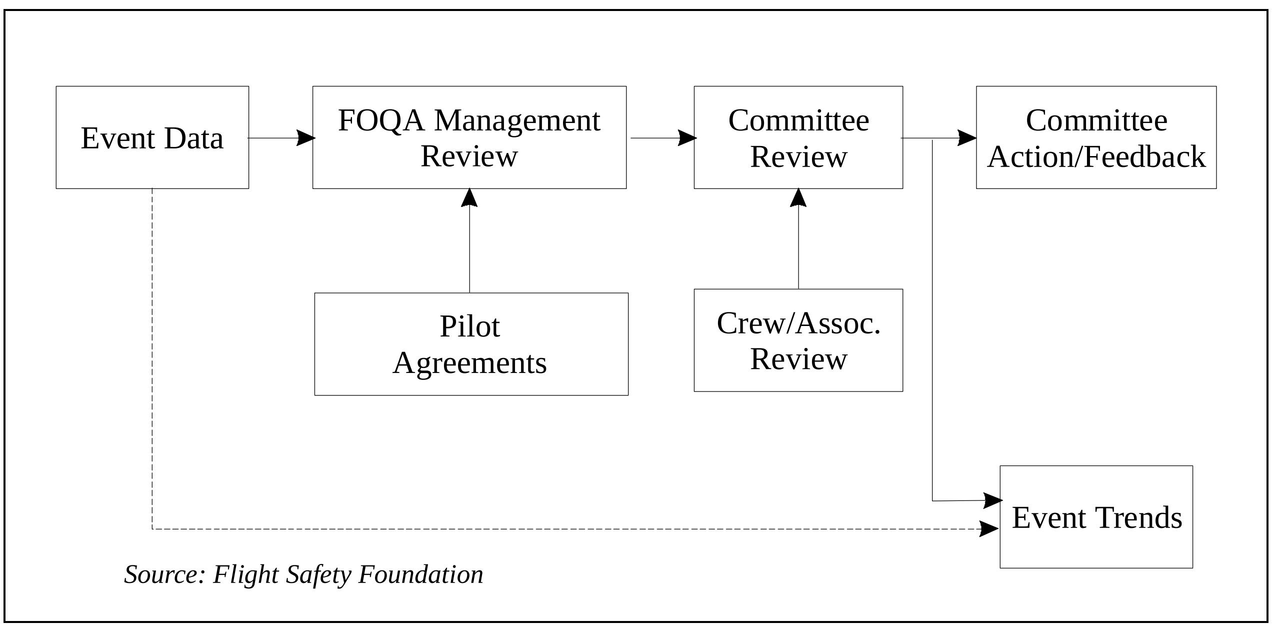


Figure 14. Event Review Process Elements

The objective in each case is to concentrate on the more serious events. In practice, relatively few events are so far outside the bounds of operational tolerance that they require immediate action.

Procedures are necessary to review and validate the event reports. These reviews should be conducted by one or two technically and operationally qualified individuals; one of them should be a pilot-group representative to judge the validity of the specific events. For some users, up to 50 percent of the reports are invalid for such reasons as erroneous data, improperly adjusted sensors, acceptable localized operational situations, and aircraft or system reconfigurations that the software had not been updated to include. (Software filtering is incorporated to reduce this problem, but manual reviews remain necessary.)

After being validated, the event is evaluated to determine if trend analysis is required or if it is an excursion that warrants further review and possible feedback from the crew. If there is any indication that the aircraft may have suffered structural stress, engine damage, or other system effects, the appropriate engineering or maintenance department should be notified immediately. If feedback from the flight crew is determined to be necessary, several alternative procedures may be followed. Users can establish a formal process of committee review to reach a consensus on the need to contact the crew. Alternatively, a user may simply provide the event information to the crew's chief pilot and request that he identify and contact the crew for feedback. One operator in the study believed that self-improvement can be enhanced by sending the information directly to the captain.

Although not all FOQA users use committees to make the crew-contact decision, all users should have some form of event-review committee that meets periodically to discuss events and trends. These committees would be composed typically of management reqresentatives of flight operations, flight training, flight standards, flight safety and performance engineering (flight technical), and a designated pilot association representative. The schedule for these committee meetings varies among users, but it is usually monthly. Serious events are handled immediately.

If there is a decision to contact the crew, this may be accomplished by the pilot association representative. The management-pilot agreement should stipulate how the crew is identified. The information from the captain will be shared only verbally at the next scheduled committee meeting. This feedback may be expedited if necessary.

Other problems also should be discussed in committee and further action taken by the appropriate committee representative.

28. DATA FEEDBACK AND RESULTANT ACTIONS. Corrective actions can be reflected in training emphasis, pilot bulletins, pilot briefings, flight standards agendas, company procedures, ATC procedures, flight standards procedures, airport bulletins, and navigational chart improvements. In some cases, modification to training programs or operational policies and procedures may be required. Fleet training managers and check airmen are also involved in the timely dissemination of operational changes. Periodic reviews of negative trends are conducted in much the same way as other flight safety or quality assurance processes.

29. DATA TRENDING AND RECORDS RETENTION. The value of FOQA programs is the early identification of flight-irregularity trends that indicate a deterioration of operational integrity. Users permit these data to be used for safety enhancement purposes only, to get vital operational information that is not available in any other way. Trended data are used to indicate when and where operational changes are necessary.

The trending data bases are arranged to enable the user to evaluate trends for each event severity level. Selected individual identifying characteristics are removed, but data may still be associated with an aircraft type, flight origin, destination, and month.

The data base may be analyzed using an off-the-shelf software application or a multipurpose, user-developed program. A trending capability is designed usually into the FOQA analysis applications offered by equipment manufacturers and suppliers. The software applications apply, sort, and trend information by keywords.

FOQA data may be retained in one or more of the following categories: 1) identified, 2) trended, or 3) archived.

Identified Data generally have associated records that could be correlated to a specific flight. All FOQA data fall into this category when they are reviewed initially. The retention period for this category of data should be as short as possible. Operators may choose to retain all aircraft raw data or only peak exceedance values.

Trended Data are usually retained for several years or more. These data are maintained on tape or disk drives and may be linked to a mainframe computer storage system. Data includes peak values for the related events as well as a wide range of flight- and event-related elements. Trip and date information are not included.

Archived Data are retained for special studies that might be considered important later as a result of a new safety issue or a need to reexamine an old one. De-identified data is particularly valuable in exploring unresolved issues as other information becomes available. To satisfy these objectives, the archived data generally are the complete raw flight data records.

30. SOFTWARE CONSIDERATIONS. The continued effectiveness and value of an airline FOQA program are dependent in part on its ability to adapt to changing fleet compositions, system configurations, flight operating procedures, and external operational environment variations. The capability to accommodate these constantly changing variables depends on the airborne and ground software.

The capability to conveniently change or modify programmed parameters, event categories, event trigger limits, and data sample rates has always been a problem with FOQA recording and analysis software. Changes to applications software at the manufacturer level are costly and time consuming. User-level changes have been limited often to a few parameters and event limits, and even then usually require the talents of an engineering or systems programmer.

Substantial improvements have been made by systems and software manufacturers on some of the newer AIMS. Menu-driven edit programs are provided as standard packages or options for most of the referenced requirements. Ground-based analysis software options from some suppliers include:

a. Menu-driven instructions only, for which the operator must do all programming;

b. Starter kits that provide a complete set of basic parameter tables and event algorithms, along with instructions for further expansion; and

c. Complete event program packages customized to customer requirements.

SECTION 5. CREW MEMBER AND LABOR ORGANIZATIONS

31. GENERAL ISSUES AND CONCERNS. Pilot views concerning FOQA programs are primarily represented by the major pilot associations. Although the FOQA report does not formally document the views of non-union crew members, it is usual for members of these pilot groups to participate in the major pilot associations' safety reviews of flight recorder programs.

The following principles represent the pilot association views of FOQA issues:

a. A positive, cooperative relationship between management and flight crew representatives must be established and maintained;

b. Representatives of the pilot group/ion should be part of the design, implementation, and operation of the FOQA program;

c. The FOQA program should not be used as a training or checking substitute;

d. Designated flight crew representatives should contact the crew for follow-up;

e. Provisions must be established to prevent collected data from being used in disciplinary actions;

f. Data derived solely from flight analysis safety programs should remain confidential, with restricted access to flight crew identification;

g. All exceedance data should be de-identified as soon as possible; and

h. All identified data should be destroyed as soon as possible except data that is used for trend analysis.

32. **DATA COLLECTION CONSIDERATIONS**. Some industry representatives view of FOQA's scope and the large number of exceedances to be reviewed is broader than any found among present users and more nearly represents the Total Quality Management (TQM) concept discussed in the FOQA report. A system based on the expanded list of parameters (Appendix D) would be satisfactory for newer aircraft in the United States. Operators of older and less sophisticated aircraft could obtain a safety benefit with a limited program based on current FAA- mandated DFDRs.

33. **DATA SECURITY AND PROTECTION ISSUES**. Protection of FOQA data in an airline environment has been discussed in Sections 2 and 4. Regulatory agency and public use of the data are major concerns of pilots and airline management.

SECTION 6. STAFFING CONSIDERATIONS

34. STAFFING ESTIMATES. In establishing FOQA program staffing, an airline must consider whether to conduct the data analysis in-house or contract the analysis to an outside service. The decision depends largely on the scope (objectives, fleet composition, and aircraft data source capabilities) of the FOQA program. Users have found that existing staff can operate a FOQA program for up to 20 aircraft. Experience has demonstrated that one additional person is needed for each 20 additional aircraft; a dedicated ground station operated by specialists is required for more than 20 aircraft.

35. OUTSIDE SERVICE OPTIONS. Some users may contract for data analysis services because of limited resources, program scope, or other reasons. Currently, there is a limited number of analysis services in the United States, but the number of analysis service is likely to increase as more FOQA programs are implemented.

SECTION 7. DESIGN DRIVERS

Design drivers are objectives to be considered when designing a FOQA program. They lead to decisions in formulating design specifications, in selecting the hardware and software, and in developing processes.

36. TOTAL SYSTEM DRIVERS. These drivers lead to management decisions on the fundamental size, scope, and basic operation of the program. They need to be discussed early in the design process because the drivers for the second-level systems lead to preliminary design decisions. Considerations at the total-system level include:

a. **Fleet Analysis** -- This requires identification of aircraft type, aircraft retention periods, current and future restraints on FOQA applications, and required fleet coverage to achieve desired results.

b. **FOQA Reporting Needs** -- This requires identification of desired reports and the content of each and in the definition of events and parameters to be measured, recorded, processed, and analyzed. This process will lead to identification of equipment needs for both the airborne and ground systems.

c. **Required Recording Devices** -- This requires definition of the level of recording technology required on each aircraft to achieve the FOQA objectives.

d. **Other Recorder Systems and Reporting Needs** -- If other data systems, such as ACMS, maintenance, engine, and ACARS systems, are in use or contemplated, they should be evaluated as FOQA data sources and, if appropriate, included in an integrated data processing plan.

e. **Data Retrieval Methods** -- This includes identification of data removal and transmission (to ground station) procedures.

f. **On-board vs. Ground Data Processing** -- The raw data may be processed entirely by the ground station or may be processed on-board, using more complex equipment. The added on-board complexity offers some attractive benefits such as data compression (storage capacity), reduced time to identify problems, simplification of the retrieval process, and flexibility in modifying programs.

g. **Centralized vs. Multiple Ground Stations** -- Concentration of all data processing within one department (e.g., maintenance) tends to drive the FOQA analytical procedure into a large centralized facility. In these cases, the requirement for a limited access facility near flight operations management and safety organizations should also be considered. Other programs allow widely separated hub locations to each have access to the FOQA data. These are usually PC-based systems, particularly if they are combined with on-board processing and simplified reporting and display requirements.

h. **Management of the Data Processing Function(s)** -- The FOQA data may be processed with data required by other applications or it may be separated (either in the retrieval process or after initial reduction) and sent to a FOQA-dedicated facility for completion of the processing. The latter provides better protection from inappropriate uses. The former approach usually assigns processing to the maintenance organization, the latter to flight operations or the safety organization.

i. **Software and Software Changes** -- Software applications can be purchased off-the-shelf or the airline may contract for its development or produce it internally. If the airline has the capability, it should consider in-house software development. This will ease interpretation of results and allow changes to the onboard and ground station software more quickly at reduced cost. Smaller airlines will probably purchase most of their software but an in-house capability to adjust exceedance limits should be maintained.

j. **Costs** -- The airborne system can be implemented with the addition of a QAR and a PC-based ground station at little cost. If measurements must be added beyond those provided by the FAA-mandated DFDR, developing a FOQA system for the earlier generation aircraft can increase costs substantially. Conversely, acquisition of newer aircraft with engine or ACMS data capability adds little to the additional cost of a FOQA system.

37. AIRBORNE SYSTEM DRIVERS. Design drivers for the airborne system include the drivers at the total system level, because this second level system must be compatible with the top level. Many of these drivers depend on the type of airplane, the operations manual for that airplane, and the airline's own flight operations policies and procedures. Airborne system drivers include:

a. Event categories -- These are developed to meet the reporting needs.

b. Parameters -- Those to be measured will support the analysis algorithms for each event category. Frequency of recording must be established for each parameter.

c. Exceedance limits -- These must be set for each event category.

d. Digital format -- Format to be used must be identified.

e. Recording capacity -- Per-flight data capacity requirements and flight intervals between data downloads must be determined.

f. Recording medium -- Choices include magnetic tape, optical disk, and solid state memory.

g. Data compression -- Continuous or intermittent recording will be used. This depends on the decision to process on-board or on the ground.

h. On-board software changes --The means for altering and loading the software must be selected.

i. Data quality -- Procedures to protect the quality of the data must be determined. This includes frequency of calibrations and self-check methods.

j. On-board hardware and software -- Hardware and software requirements must be selected.

k. Ground support equipment -- Requirements for maintenance and troubleshooting must be established.

38. GROUND SYSTEM DRIVERS. The drivers for the total system also apply to the ground system because compatibility with the top-level drivers must be maintained. In addition, certain airborne drivers affect the ground system. It is necessary to keep all three groups of driver decisions in harmony. Design drivers for the ground system include:

a. **Airborne system compatibility** -- Compatibility must be maintained, particularly in the data format, exceedance event and parameter selection, the recording medium, the means chosen for on-board software development and change, and the hardware chosen for data acquisition and management. If a DMU is included as part of the on-board hardware, the ground system will probably prepare the input data.

b. **Flight record processing capacity** -- The amount and kind of flight data to be processed in the startup program and in the mature program will affect the selection of ground system hardware. If the ground system will use non-FOQA data, these data must be considered in hardware selection.

c. **Transcription software** -- This software converts the raw recorded data into engineering units.

d. **Analysis software** -- This software runs the various analysis routines that produce the required reports such as exceedance event time histories (either tabulated or plotted), trend data, and management reports.

e. **Video displays** -- This component includes the monitors and software necessary for the data processing and analysis functions and special displays such as data plots, flight path graphics and cockpit display simulations. The latter displays are particularly important if access to the FOQA data is provided routinely to flight crews.

39. OPERATING PROCESSES. Operating and protection processes constitute the FOQA process system. Required functions should be defined during the definition period for the airborne and ground systems, then assigned to an organization or individual. A functional flow diagram should be prepared.

a. **Data retrieval flow** -- This concerns responsibility and procedures for removal, transmission, and storage of FOQA data and data storage devices.

b. **Data reduction flow** -- This concerns responsibility and procedures for data flow through the reduction process, and transmission and storage of data following the reduction process.

c. **Data analysis flow --** This concerns responsibility and procedures for FOQA data analysis. If the reduction and analysis functions are performed at the same location by the same organization, the two processes can be developed jointly.

d. **Report action flow** -- This concerns responsibility and procedures for report preparation, dissemination, analysis, and report-generated action, including committee meetings' frequency and agendas.

e. **Management action and follow-up flow** -- This is developed either as a separate process or as part of the report action flow. It assigns responsibility for action by the internal organizations receiving the reports, tracking responses, completing required activities, and tracking and reporting results.

f. **Data storage --** This concerns responsibility and procedures for data retention, including storage facilities, storage media, retention periods, and protection of data from unauthorized access.

40. PROTECTION PROCESSES. These processes protect airline management and flight crews from unwarranted legal action when infractions of FAR or operational policies and procedures are discovered through the FOQA program. They also protect flight crews from punitive actions by airline management and both airlines and crews from punitive actions by the FAA. The new FAA policy on compliance and enforcement described in AC

120-56 and AC 120-59 provides protection from FAA punitive action when carriers disclose apparent violations of the FAR before the FAA discovers them.

Protective procedures should be implemented as follows:

a. **Airline management/prior agreements** -- These are aimed at defining the roles of the parties in the operation of the FOQA program;

b. **Confidentiality** -- This process ensures that airline or crew names are not associated with any FOQA data except through rigid controls employing a minimal number of reputable individuals;

c. **Anonymity** -- This process ensures that any identification of airline flight and/or flight crews with specific FOQA flight data necessary during an analysis is eliminated permanently at the earliest possible time and in accordance with any applicable airline-pilot agreement;

d. **Crew Contact** -- This process defines the appropriate conditions for contact with a specific flight crew or individual crew member for understanding a FOQA exceedance event. It also defines appropriate uses of information derived from the contact;

e. **Data access and control --** This includes procedures to identify data requiring protection and to assign overall responsibility for data protection. It also includes procedures to protect data, provide authorized access to data and data processing or storage locations, provide authorized access to reports and other data outputs, and authorize destruction of data; and

f. **Record retention and/or destruction** -- This process will define the safeguards during the data retention period and the timing and responsibility for data destruction.

CHAPTER 3. OPERATIONAL IMPLEMENTATION CONSIDERATIONS

This chapter describes the recommended four-phase procedure for an operator to implement a FOQA program:

Phase I -- This includes overall planning to implement the total program and detailed preparation for Phases II and III.

Phase II -- The trial demonstration and evaluation phase tests the system designed by Phase I for a short period, evaluating all aspects of its operation, on one or more aircraft, and developing the operating and protective processes.

Phase III -- The flight operational evaluation phase adds more aircraft of the same type to the program so that a database sufficient for validation of the program is accumulated.

Phase IV -- The FOQA program operation phase begins when the degree of expertise will support a continuing program in all technical and management respects. It should begin with the aircraft tested in Phase II and Phase III and will expand to add the aircraft numbers and types set by the program plan. As each new type is introduced it will probably be necessary to employ a Phase II-Phase III type entry period for the evaluation of technical variations.

Resources such as the Air Transport Association's (ATA) Aviation Safety Committee, the AQP Working Group, the ALPA, Allied Pilots Association (APA), and ARINC-DFDR committee are available to assist the implementation. These resources include representatives from the airlines, aircraft and equipment manufacturers, the FAA, and the NTSB.

The implementation outline presented below can be expanded after completion of the FOQA trial program that is recommended in the FOQA report. In the meantime, if this AC is used as a guide, the airline also should use the FOQA report to formulate a program to meet its needs.

SECTION 1. PHASE I --- PREPARATION

Airline management must approve development of a FOQA program or definitive planning during Phase 1. The system design drivers should be identified and developed as discussed in Chapter 2, Section 7. This phase must define the desired product and develop plans for all following phases. The plan will be a living document requiring periodic updating. Management approval should occur before equipment purchases are committed and again before starting Phase II.

41. **<u>IMPLEMENTATION SCHEDULE, PRIORITIES AND ORGANIZATION</u>**. These should be set for the entire program. Airline departments that will be involved in the program or those that will be data users, should be identified and a special implementation organization should be established. Representation should come from flight safety, training, flight standards, engineering and maintenance departments, and the pilots' association. One or more employees who understand the airlines' present data systems also should be assigned to the group. If the airline has adopted an IEP or TQM program, representatives from those programs should be included. The organization should function as a steering committee with support personnel assigned for specialized tasks. As implementation proceeds, the organization will become responsible for long-term operation.

Initially, this group will define system drivers, operating processes, and some protection processes, and will determine the schedule and budget for FOQA program implementation.

42. **<u>SYSTEM HARDWARE, SOFTWARE AND PROCESS DEVELOPMENT</u>**. These are tailored specifically for use in the Phase II demonstration but contain the elements of the anticipated mature system. Equipment and software for the airborne and ground systems are specified and acquired, probably in quantities necessary to support the program through Phase III. Operating processes necessary for Phase I and Phase II must be completed. Protection process development should begin but completion is not required until the end of Phase II.

43. **EQUIPMENT INSTALLATION AND CHECKOUT**. Installation of airborne and ground systems will require the assistance of hardware and software suppliers. FAA certification of the airborne equipment must be planned and accomplished after the first flight of the modified aircraft. When the ground station is operable, testing of analysis software can begin, although the airborne system may require additional work.

44. **ANALYSIS SOFTWARE DEBUGGING**. Debugging and ground trials of the reduced scope data reduction and analysis software and operating processes are the final steps in this phase. The services of the software supplier(s) will be necessary. The phase ends with a system readiness evaluation prior to the first data flight.

SECTION 2. PHASE II -- TRIAL DEMONSTRATION AND EVALUATION

In this phase, the aircraft are operated by management pilots on routine flights. Data are obtained in a realistic environment to verify the operational aspects of the airborne and ground systems together with the operating processes. This small-scale evaluation confirms that the system is ready for operation and expansion. Operational and protection processes will have been tested and completed. Agreement between management and labor organizations will have been reached.

45. **DATA QUALITY ASSURANCE**. This is the first task of Phase II. It must be determined that valid data with the required accuracy are recorded in flight and are processed by the ground system in the formats and with the integrity required for satisfactory evaluation. This is a prerequisite for the next step.

46. **EVENT ENVELOPE REVIEW AND REVISION**. This step ensures that algorithms for each event category function as required and that the exceedance 1evels have been properly set to capture desired events without producing large volumes of inconsequential data. This requires careful review by the operations personnel responsible for setting the limits. This task continues through Phase III to ensure that the fully operational system will have little need for further change.

47. **SOFTWARE EVALUATION AND MODIFICATION**. These steps will identify and correct problems in the operational software for the airborne and ground systems. Close cooperation between the designers of the software and the ground system operators is vital.

48. **PROCEDURAL VALIDATION**. This step reviews and refines the operational, management, and data protection procedures and processes. Completion of this step and an overall readiness review will lead to Phase III.

SECTION 3. PHASE III - FLIGHT OPERATIONAL EVALUATION

In this phase, sufficient data are generated under realistic conditions (with nonunion pilots) to reveal latent problems not found in prior testing. Corrections made during Phase II will be evaluated. The databases and procedures designed during Phases II and III must be free of errors requiring further change because a change in any data characteristic of the operational program will make pre- and post-change results incompatible. Trend analysis, in particular, would be disrupted.

49. **EVENT ENVELOPE VALIDATION**. This is a continuation of the Phase II activity and should continue until optimal event categories, parameters, and limits have been demonstrated.

50. **TREND DATA BASE INTEGRITY REVIEW**. This step occurs when enough data have been collected to allow tracking of flight conditions and situations over time. Evaluation of the suitability of trend data, probably in two levels of severity, and correction of the data-generating processes are completed during this review.

51. **VALIDATION OF EXCEEDANCE REVIEW AND ACTION PROCEDURES**. Developed in Phase II, these procedures are re-examined to assure that exceedances are properly analyzed, procedures for contacts with flight crews are in place, and remedial action and follow-up processes operate satisfactorily, within proscribed protection rules.

52. **CONFIRMATION OF DATA FEEDBACK PROCEDURES**. These processes convey FOQA results to flight crews, and confirm that improvements occur. If they are not properly implemented, management's exposure to potential liability may be increased.

SECTION 4. PHASE IV -- FOQA PROGRAM OPERATION

A prerequisite for this phase is management approval following a comprehensive readiness review. Additional commitments of company resources might be required to implement the airline's total FOQA program. The decision should be based on the program plan developed and reviewed starting in Phase I and on an analysis of the expected benefits and results during Phase II and Phase III.

A mature program will have four primary functions:

1. Data collection;
2. Data analysis and review;
3. Data trending; and
4. Data feedback and resultant action.

53. **DATA COLLECTION**. This step occurs routinely and flows from aircraft to line stations to analysis locations via data link or company mail.

54. **DATA ANALYSIS AND REVIEW**. This step continues daily. Exceedances are examined frequently to identify trends or serious operational issues. Reports of exceedances are prepared periodically for review committee action, or immediately if required.

55. **DATA TRENDING**. This step trends exceedance data over time. Periodic reports are prepared for users showing frequency by event category or on a per-flight basis. Airlines may exchange trend data with one another through industry associations or an FAA data base (if available).

56. **<u>DATA FEEDBACK AND RESULTANT ACTIONS</u>**. These are continuing vital processes, and management must ensure continued innovation and improvement. The processes should be integrated into existing corporate TQM and the IEP programs if possible.

CHAPTER 4. PLANNING FOR FAA PARTICIPATION

57. **REVIEW OF PROGRAM POLICIES AND PROCEDURES**. Once the airline has completed implementation of the FOQA program, a review of program policies and procedures should be made. An airline may also inform the local FAA branch office of its intentions and progress.

The program review should analyze the relationship between the airline's FOQA program and IEP if it has adopted the latter per AC 120-59. Even if an airline chooses not to implement the voluntary IEP, to avoid punitive action it should voluntarily disclose to the FAA apparent violations of the FAR revealed during the FOQA program.

Airlines adopting AQP per SFAR 58 also should review procedures for use of FOQA information in support of AQP validation and revisions to training cycles as per AC 120-54.

58. **DATA TRENDS AND PROGRAM OPERATION FEEDBACK**. Periodic reviews of trends and lessons learned from the FOQA program will help the airline and FAA inspectors decide where to concentrate safety efforts. Information used in these reviews should be de-identified according to company procedures. The focus should be on trends rather than specific flight data and exceedances.

The FAA inspector should be considered a resource to help coordinate the FOQA program with other FAA programs, such as air traffic, airports, engineering, and maintenance.

APPENDIX A. EVENT CATEGORIES USED IN CURRENT PROGRAMS

USER SUMMARY

EVENT CATEGORIES MONITORED BY MODE OF FLIGHT*

TAXI MODE EVENTS	TAKEOFF MODE EVENTS	CLIMB MODE EVENTS	APPROACH MODE EVENTS	LANDING MODE EVENTS	GO-AROUND MODE EVENTS
EGT ON ENGINE START	TAKEOFF THRUST SETTING	CLIMB THRUST	WIND SHEAR BELOW 1500 FT	SPEED HIGH AT TOUCHDOWN	*G/A ACTIVIATION*
NI/EPR ON TAXI	EGT ON TAKEOFF	CLIMB EGT	GEAR DOWN LATE	*HIGH/LOW PITCH ON LDG*	G/A THRUST
TAXI SPEED	HORIZONTAL STABLIZER SET	INITIAL CLIMB PITCH RATE	*GEAR EXTENSION SPEED*	ABNORMAL HIGH PITCH ON ROLLOUT	
LATERAL ACCLERATION	TAKEOFF ACCLERATION	*CLIMB PITCH ALTITUDE*	SPEEDBRAKE ARM DELAY	*RANK ANGLE LIMIT*	
VERTICAL ACC	*VERTICAL ACC*	*RANK ANGLE LIMIT*	*SPEEDBRAKE EXTENSION*	*INCORRECT FLAP LANDING*	
	HIGH ROTATION RATE	*CLIMB SPEED HI/LO*	APPROACH THRUST	OVERWEIGHT LANDING	
	LOW ROTATION RATE	*CLIMB HEIGHT LOSS*	*BANKANGLE LIMIT*	*NORMAL ACCLERATION*	
	PITCH ALTITUDE HIGH	REDUCED LIFT MARGIN	*HIGH DESCENT RATE*	VERTICAL ACCLERATION: BOUNCE	
	EARLY ROTATION	GEAR UP EARLY	*FLAP PLACARD SPEED*	VERTICAL ACCLERATION: BOUNCE	ALL FLIGHT MODE EVENTS
	LATE ROTATION	GEAR UP SELECTED SPEED	*LOW ALTITUDE-3 TO 2 MIN OUT*	SPOILERS LATE TO DEPLOY	*NORMAL ACCLERATION*
	UNSTICK SPEED HI/LO	*GEAR UP SPEED*	*GLIDESLOPE DEVIATION HI/LO*	REVERSE THRUST LIMIT(SPO)(PWR)	*BANK ANGLE LIMIT*
	HEADING DEVIATION	*EARLY FLAP/SLAT CHANGE*	*LOCALIZER DEVIATION*	EGT LIMIT	*STICK SHAKER*
	TIRE LIMIT SPEED	*TIME TO 1000 FT LIMIT*	LOW POWER ON FINAL	*HEADING DEVIATION ON ROLL*	*GPWS OPERATION*
	ABORT TAKEOFF	*VERTICAL ACC*	*LATE LANDING ELAPS*		*PILOT EVENT MARKER*
			GROSS POWER INCREASE ON FINAL		*FLAP PLACARD SPED*
			OVERSHOOT ON APPROACH		EXCESSIVE ROLL RATE
			HEADING CHANGE EXCESSIVE (LOW)		ABNORMAL ELP/BLTCONE
			APPROACH SPEED HI/LO		FLAP/PLAT ALT LIMIT
			TAIL WIND LIMIT		REDUCED LIFT MARGIN
			REVERSERS DEPLOYED IN FLIGHT		ALPHA PROTECTION
			SPEED DEVIATION AT THRESHOLD		
			NORMAL ACCLERATION		

** BOLD TYPEFACE INDICATES COMMON TO > 50% OF SURVEYED OPERATIONS*

APPENDIX B. EVENT CATEGORY POSSIBILITIES FOR STATE-OF-THE-ART PROGRAMS

EVENT CLASSIFICATIONS BY OPERATIONAL MODE

TAXI-OUT	TAKEOFF	CLIMB	CRUISE	DESCENT/ APPROACH	LANDING	TAXI IN
• Abmn. flt. cntl. pos.	• Abmn. flt. cntl. pos.	• Abn. flt. cntl. pos.	• Abn. flt. cntl. pos.	• Abn. flt. cntl. pos.	• Abn. flap/slat speed brake config.	• Abn. flt. cntl. pos.
• Abmn. flap/slat speed brake config.	• Abmn. flap/slat speed brake config.	• Abn. flap/slat speed brake config.	• Bank angle	• Abn. flap/slat speed brake config.	• Abn. flt. cntl. pos.	• Abn. flap/slat speed brake config.
• Excessive rev. thurst	• Auto break status	• Alt. loss	• Excessive roll rate	• Approach speeds	• Auto break status	• Excessive rev. thrust
• Ground speed	• Bank angle	• Bank angle	• Flap/slat speed/alt.	• Approach alt.	• Bank angle	• Ground speed
• Lat. accel.	• Exc. roll rate	• Climb speed	• GPWS	• Auto break status	• Excessive EGT	• Lat. accel.
• Long. accel.	• Excess, EGT	• Excessive roll rate	• Lat. accel.	• Excessive thrust	• Excessive thrust	• Long. accel.
• Pilot event mkr.	• Excessive rev. thurst	• Flap/slat speed/altitude	• Long. accel.	• Ex. roll rate	• Excessive rev. thrust	• Pilot event mkr.
• Reverser deply.	• Heading dev.	• Gear up speed	• Max. alt. exceed.	• Flap/slat speed/alt.	• Excessive roll rate	• Reverser dply.
• Stall avoid.	• Lat. accel.	• GPWS	• Mno exceed.	• Gear extend speed	• Flap setting	• Stall avoid
• Stick shaker	• Long. accel.	• Lat. accel.	• Pilot event mkr.	• Glideslope deviation	• Go around	• Stick shaker
• Thurst	• Pilot event mkr.	• Long. accel.	• Reverser dply.	• Go around	• Ground spoiker dply.	• Thurst
• Vert. accel.	• Pitch attitude	• Pilot event mkr.	• Speed below 10,000 ft.	• GPWS	• Heading deviation	• Vert. accel.
• Windshear det.	• Rev. deply.	• Pitch attitude	• Stall avoid	• Ground spoiler not armed	• Lat. accel.	• Windshear det.
	• Rotation rate	• Reduce lift margin	• Stick shaker	• Lat. accel.	• Long. accel.	
	• Stall avoid.	• Rev. deply.	• TCAS	• Localizer deviation	• Pilot event mkr.	
	• Stick shaker	• Speed below 10,000 ft.	• Vert. accel.	• Long. accel.	• Pitch attitude	
	• Takeoff abort	• Stall avoid.	• Vmo exceed.	• Low thrust	• Reverse dply.	
	• Tire limit speed	• Stick shaker		• Pilot event mkr.	• Spoiler dply.	
	• Unstick speed	• TCAS		• Rate of descent	• Stall avoid	
	• Vertical accel.	• Time to 1,000 ft.		• Reduced lift margin	• Stick shaker	
	• Windshear det.	• Vert. accel.		• Rev. dply.	• Touchdown speed	
		• Windshear det.		• Speed below 10,000 ft.	• Vertical accel.	
				• Stall avoid	• Windshear	
				• Stick shaker		

- TCAS
- Vert. accel.
- Windshear

APPENDIX C. PARAMETERS USED IN CURRENT PROGRAMS

USER OPERATOR SUMMARY

USER-21R
REV-8

TYPICAL PARAMETERS UTILZED FOR COMMON EVENT CATEGORIES

LIMIT MONITORED EVENT CATEGORIES	PARAMETERS USED TO ESTABLISH EVENT OCCURRANCES FOR SPECIFIC FLIGHT MODES					
	TAKEOFF MODE	CLIMB MODE	CRUISE MODE	APPROACH MODE	LANDING MODE	GO AROUND
NORMAL ACCELERATION LIMIT	NORMAL ACCELERATION AIR GROUND LOGIC	NORMAL ACCELERATION FLAP POSITION AIR GROUND LOGIC	(SAME AS CLIMB)	(SAME AS CLIMB)	(SAME AS TAKEOFF)	(SAME AS CLIMB)
ROTATION RATE HIGH	PITCH ATTITUDE RELATIVE TIME AIR GROUND LOGIC	———	———	———	———	———
PITCH ATTITUDE HIGH	PITCH ATTITUDE RELATIVE TIME AIR GROUND LOGIC	PITCH ATTITUDE RELATIVE TIME AIR GROUND LOGIC	———	———	PITCH ATTITUDE RELATIVE TIME AIR GROUND LOGIC	(SAME AS CLIMB)
UNSTICK SPEED HI/LOW	COMPUTED AIRSPEED AIR GROUND LOGIC	———	———	———	———	———
ABORT TAKEOFF	COMPUTED AIRSPEED **ENGINE THRUST ???**	———	———	———	———	———
BANK ANGLE LIMIT	———	ROLL ATTITUDE ALTITUDE	———	(SAME AS CLIMB)	ROLL ATTITUDE ATTITUDE AIR GROUND LOGIC	(SAME AS CLIMB)
CLIMB SPEED HI/LOW	———	COMPUTED AIRSPEED PITCH ATTITUDE ALTITUDE **VERTICAL SPEED**	———	———	———	———
CLIMB HEIGHT LOSS	———	ATTITUDE VERTICAL SPEED	———	———	———	(SAME AS CLIMB)
GEAR UP SPEED	———	COMPUTED AIRSPEED GEAR IN TRANSIT	———	———	———	(SAME AS CLIMB)
EARLY FLAT/SLAT CHANGE	———	ALTITUDE COMPUTED AIRSPEED FLAT/SLAT POSITION AIR GROUND LOGIC	———	———	———	———
FLAP PLACARD SPEED	———	COMPUTED AIRSPEED FLAP POSITION	(SAME AS CLIMB)	(SAME AS CLIMB)	(SAME AS CLIMB)	(SAME AS CLIMB)

USER OPERATOR SUMMARY

USER-21R
REV-8

TYPICAL PARAMETERS UTILZED FOR COMMON EVENT CATEGORIES

LIMIT MONITORED EVENT CATEGORIES	PARAMETERS USED TO ESTABLISH EVENT OCCURRANCES FOR SPECIFIC FLIGHT MODES					
	TAKEOFF MODE	CLIMB MODE	CRUISE MODE	APPROACH MODE	LANDING MODE	GO AROUND
TIME TO 1000 FT LIMIT	———	ALTITUDE AIR GROUND LOGIC RELATIVE TIME	———	———	———	———
Vmo EXCEEDENCE	———	BARO ALTITUDE COMPUTED AIRSPEED	BARO ALTITUDE COMPUTED AIRSPEED	BARO ALTITUDE COMPUTED AIRSPEED	———	———
Mmo EXCEEDENCE	———	BARO ALTITUDE MACH SPEED	BARO ALTITUDE MACH SPEED	BARO ALTITUDE MACH SPEED	———	———
MAX OPERATING ALT	———	———	BARO ALTITUDE	———	———	———
GEAR EXTENSION SPEED	———	———	———	COMPUTED AIRSPEED GEAR IN TRANSIT	———	———
HIGH DESCENT RATE	———	———	———	ALTITUDE VERTICAL SPEED	———	———
LOW ALTITUDE- 3 TO 2 MIN TO TO	———	———	———	———	BARO ALTITUDE AIRGROUND LOGIC RELATIVE TIME	———
GLIDESLOPE DEVIATION	———	———	———	———	GLIDESLOPE DEVIATION	———
LATE LANDING FLAPS	———	———	———	———	BARO ALTITUDE FLAP POSITION	———
APPROACH SPEED HI/LO	———	———	———	———	COMPUTER AIRSPEED **??? SPEED**	———
INCORRECT FLAP LANDING	———	———	———	———	FLAP POSITION AIRGROUND LOGIC	———
HEADING DEVIATION ON ROLLOUT	———	———	———	———	MAGNETIC HEADING COMPUTER AIRSPEED AIRGROUND LOGIC	———
G/A ACTIVATION	———	———	———	———	———	RADIO ALTITUDE

USER OPERATOR SUMMARY

USER-21R
REV-8

TYPICAL PARAMETERS UTILZED FOR COMMON EVENT CATEGORIES

LIMIT MONITORED EVENT CATEGORIES	PARAMETERS USED TO ESTABLISH EVENT OCCURRANCES FOR SPECIFIC FLIGHT MODES					
	TAKEOFF MODE	CLIMB MODE	CRUISE MODE	APPROACH MODE	LANDING MODE	GO AROUND VERTICAL SPEED
STICK SHAKER	STALL WARNING	STALL WARNING	STALL WARNING	STALL WARNING	STALL WARNING	STALL WARNING
GPWS OPERATION	GPWS WARNING	GPWS WARNING	GPWS WARNING	GPWS WARNING	GPWS WARNING	GPWS WARNING
PILOT EVENT MARKER	PILOT EVENT MARK	PILOT EVENT MARK	PILOT EVENT MARK	PILOT EVENT MARK	PILOT EVENT MARK	PILOT EVENT MARK

APPENDIX D. PARAMETER POSSIBILITIES FOR STATE-OF-THE-ART PROGRAMS

Monitored Parameters
Taxi Out

Aileron Pos.
Aileron Trim Pos.
Air/Ground Sensing
Auto Pilot Engage Status
Auto Pilot Mode Status
Brake Press. All Wheels
Brake Pedal Pos.
Control Column Pos.
Control Wheel Pos.
Elevator Position
EPR/N
Flap Handle Pos.
GMT
Ground Speed
Heading
Horizontal Stab Pos.

L.E. Flap Pos.
L.E. Slat Pos.
Latitude/Longitude
Lat. G
Long. G
Microphone Keying
Pilot Event Mkr.
Pitch Trim Setting
RAT
Relative Time
Reverse Thrust Lever Pos.
Reverser Deployment
Rudder Trim Pos.
Rudder Pos.
Rudder Pedal Pos.
SAT/TAT

Spoiler Pos.
Spoler Handle Pos.
T.E. Flap Pos.
Vert. G

Additional Parameters
Electronic Aircraft

Barometric Setting
Computer Failure (Eng & Flt Cntrl)
Data Buss Failure
EFIS Format or MFD Format
EICAS Format
Side stick controller input(each pilot)

Monitored Parameters
Take-Off

AFCS Mode Annun.
Aileron Pos.
Aileron Trim Pos.
Air Speed Coarse
Air Speed Fine
Air/Ground Sensing
Altitude
Angle of Attack
Auto Brake Status
Auto Pilot Mode Status
Auto Pilot Engage
Auto Throttle Engage Status
Bank Angle
Brake Press All
Brake Pedal Pos.
Rudder Pedal Pos.

Control Column Pos.
Control Wheel Pos.
EGT
Elevator Pos.
EPR/N
Flap Handle Pos.
Flight Director Status
Flight Director Mode
FMC Display (ea. pilot)
Fuel Flow
GMT
Ground Spoiler
Ground Speed
Heading
Horizontal Stabilizer Pos.
Vert. G.

L.E. Flap post.
Latitude/Longitude
Lat. G.
Long. G.
L.E. Slat Post
Microphone Keying
Pilot Event Mkr.
Pitch Attitude
Pitch Trim Setting
Radio Altitude
RAT
Relative Time
Reverse Lever Pos.
Reverser Deployment
Rudder Pos.
Computer Failure (Eng. & Flt.

Monitored Parameters
Take-Off

Rudder Trim Pos.
SAT/TAT
Stall Avoid
Stick Shaker
T.E. Flap Post.
Throttle Pos.

Wind Dir/Vel
Windshear Det.

Additional Parameters
Electronic Aircraft

Barometric Setting

Control)

Data Buss Failure
EFIS or MFDS Format
EICAS Format
Nav. RCVR Freq. Sel.
Side Stick Controller Input (Each pilot)

Monitored Parameters
Climb

AFCS Mode Annun.
Aileron Pos.
Aileron Trim Pos.
Air Speed Fine
Air Speed Coarse
Altitude
Angle of Attack
Auto Pilot Engage Status
Auto Pilot Mode Status
Auto Throttle Engage Status
Bank Angle
Control Column Pos.
Control Wheel Pos.
EGT
Elevator Pos.
EPR/N
Flap handle position
Flight Director Mode
Flight Director Status
FMC Display (both pilots)
FMC Wind

Fuel Flow

Gear Lever Pos.
GMT
GPWS
Heading
Horizontal Stab.
L.E. Flap Pos.
L.E. Slot Pos.
Lat. G.
Latitude/Longitude
Lnd. Gear Pos.
Long. G.
Mach. No.
Microphone Keying
Pilot Event Mkr.
Pitch Attitude
Pitch Trim Setting
Radio Altitude
RAT
Relative Time
Reverser Dply.
Rudder Pos.

Rudder Trim Pos.

Rudder Pedal Pos.
SAT/TAT
Stall Avoid
Stick Shaker
Pos.T.E. Flap Pos.
TCAS Event
Throttle Pos.
Vert. G.
Windshear Det.

Additional Parameters
Electronic Aircraft

Barometric Setting
Computer Failure (Eng. & Fit. Cntl.)

Data Buss Failure
EFIS or MFD Format
EICAS Format
Nav. RCVR Freq. Sel.
Side Stick Controller Input (Each Pilot)

Monitored Parameters
Cruise

AFCS Mode Annun.
Aileron Pos.

GMT
GPWS

SAT/TAT
Stall Avoid

Monitored Parameters
Cruise

Aileron Trim Pos.
Airspeed Fine
Airspeed Coarse
Angle of Attack
Auto Throttle Engage Status
Auto Pilot Mode Status
Auto Pilot Engage Status
Bank Angle
Control Column Pos.
Control Wheel Pos.
EGT
Elevator Pos.

EPR/N
Flap Handle Pos.
Flight Director Status
Flight Director Mode
FMC Display (both pilots)

FMC Winds
Fuel Flow

Heading
Horizontal Stab. Pos.
L.E. Slat Pos.
L.E. Flap Pos.
Latitude/LongitudeVert. G.
Lat. G.
Long. G.
Mach No.
Microphone Keying
Pilot Event Marker
Pitch Attitude
Pitch Trim Setting

RAT
Relative time
Reverser Deployment
Rudder Pos.
Rudder Pedal Pos.Side Stick Controller Input (Each Pilot)
Rudder Trim Pos.
Rudder Pos.

Stick Shaker
T.E. Flap Pos.
TCAS Event
Throttle Pos.

Windshear Det.

Additional Parameters
Electronic Aircraft

Barometric Setting
Computer Failure (Eng. & Flt. Cntrl.)

EFIS or MFD Format/Display
EICAS Format
Nav. RCVR Freq. Sel.

Monitored Parameters
Descent/Approach

AFCS Mode Annun.
Aileron Pos.
Aileron Trim Pos.

Airspeed Fine
Airspeed Coarse
Altitude
Angle of Attack
Auto Pilot Mode Status
Auto Pilot Engage Status
Auto Throttle Engage Status
Auto-Brake Status
Auto-Speed Brake Status
Bank Angle
Microphone Keying
Outter Marker Passage
Pilot Event Mkr.

Control Column Pos.
Control Wheel Pos.
EFIS or MFD Format/Display

EGT
Elevator Pos.
EPR/N
Flap Handle Pos.
Flight Director Status
Flight Director Mode
FMC Winds
FMC Display (both pilots)
Fuel Flow
Gear Lever Pos.
Rudder Pedal Pos.
Rudder Trim Pos.
SAT/TAT

Glideslope Position
GMT
GPWS

Ground Speed
Heading
Horizontal Stab Pos.
L.E. Slat Pos.
L.E. Flap Pos.
Lat. G.
Latitude/Longitude
Lnd. Gear Pos.
Localizer Position
Long. G.

Additional Parameters
Electronic Aircraft

Monitored Parameters
Descent/Approach

Pitch Attitude	Stall Avoid.	Baro Setting
Pitch Trim Setting	Stick Shaker	Computer Failure (Engine and Ft. Cont.)
Radio Altitude	T.E. Flap Pos.	
RAT	TCAS Event	Decision Height
Relative Time	Throttle Pos.	EFIS or MFD format
Reverser Deployment	Vert. G.	EICAS Format
Rudder Pos.	Windshear Det.	Nav. RCVR Freq. Sel.
		Side stick controller input (ea. pilot)

Monitored Parameters
Landing

AFCS Mode Annun.	FMC Winds	Rudder Trim Pos.
Aileron Trim Pos.	FMC Display (both pilots)	Rudder Pos.
Aileron Pos.	Fuel Flow	Rudder Pedal Pos.
Air/Ground Sensing	GMT	SAT/TAT
Airspeed Fine	Gnd. Spoiler Deployment	Stall Avoid.
Airspeed Coarse	Ground Speed	Stick Shaker
Altitude	Heading	T.E. Flap Pos.
Angle of Attack	Horizontal Stab. Pos.	Throttle Pos.
Auto-Brake Status	L.E. Flap Pos.	Vert. G.
Auto-Pilot Engage Status	L.E. Slat Pos.	Windshear Det.
Auto-Pilot Mode Status	Land Gear Pos.	
Auto-Speed Brake Status	Land Gear Lever Pos.	
Auto-Throttle Engage Status	Latitude/Longitude	
Bank Angle	Lat. G.	
Brake Press. All	Localizer Pos.	
Brake Pedal Pos.	Long. G.	
Control Wheel Pos.	Microphone Keying	
Control Column Pos.	Pilot Event Mkr.	
EGT	Pitch Attitude	
Elevator Pos.	Pitch Trim Setting	
EPR/N1	Radio Altitude	
Flap handle position	RAT	
Flight Director Status	Relative Time	
Flight Director Mode	Reverser Deployment	

Additional Parameters
Electronic Aircraft

Barometric Setting
Computer Failure (Eng. & Fit. Cntl.)

Decision Height
EFIS or MFD Format/Display
EICAS Format
Nav. RCVR Freq. Sel.
Side Stick Controller Input(Each Pilot)

Monitored Parameters
Taxi In

Aileron Trim Pos.	Heading	Rudder Trim Pos.
Aileron Pos.	Horizontal Stab. Pos.Rudder Pos.	
Air/Ground Sensing	L.E. Slat Pos.	SAT/TAT
Auto-Pilot Engage Status	L.E. Flap Pos.	Spoiler Handle Pos.
Auto-Pilot Mode Status	Latitude/LongitudeT.E. Flap Pos.	
Brake Press All	Lat. G.	Vert. G.
Brake Pedal All	Long. G.	
Control Column Pos.	Microphone Keying	**Additional Parameters**
Control Wheel Pos.	Pilot Event Market	**Electronic Aircraft**
Elevator Pos.	Pitch Trim Setting	
EPR/N1	RAT	Computer Failure (Eng. & Fit. Cntl.)
Flap Handle Pos.	Relative Time	
GMT	Reverse Lever Pos.	EFIS or MFD Format/Display
Ground Speed	Reverser Dply.	EICAS Format
Ground Spoiler Pos.	Rudder Pedal Pos.	Side stick controller input (both pilots)

APPENDIX E. FOQA I&O Plan Template

1. BACKGROUND

The following material provides boilerplate that summarizes the foundation and relevant FAA references for FOQA programs. It can be modified as appropriate by each airline.

Section 601(b) of the Federal Aviation Act of 1958 states: "In prescribing standards, rules, and regulations, and in issuing certificates under this title, the Secretary of Transportation shall give full consideration to the duty resting upon air carriers to perform their services with the highest possible degree of safety in the public interest." Flight Operational Quality Assurance (FOQA) is a defined as a program to improve flight safety by providing more information about, and greater insight into, the total flight operations environment through selective automated recording and analysis of data generated during flight operations. Analysis of data can reveal situations requiring improved operating and training procedures, equipment and supporting infrastructure. (Flight Safety Foundation).

In support of the public safety objective, the FAA has publicly endorsed the development and implementation of voluntary FOQA programs as a tool for continuously monitoring and evaluating operational practices and procedures. In AC 120-59 (Air Carrier Internal Evaluation Programs), the FAA states that "public safety is enhanced if deficiencies are identified and immediately corrected when they are discovered by the certificate holder rather than when they are discovered by the FAA." FOQA programs can provide quantitative and objective information necessary to identify deficiencies during the certificate holder’s internal audit and evaluation process. The FAA Flight Standards Strategic Management Plan 1992-1997 discusses eight major goals and supporting objectives to carry out its mission to "provide the public with accident-free aircraft operations through the highest standards in the world." Two of the goals are relevant to the FOQA program: "Develop an effective and efficient global surveillance and certification system" (Goal 5), and "Achieve compliance through partnership" (Goal 6).

The FOQA program is based on the premise that air carriers have prime responsibility for continuously monitoring and ensuring that their operations are safe and in compliance with their operating standards and the FAR. The FOQA program will assist certificate holders in identifying and addressing operational deficiencies and trends that are not generally detectable with other procedures. The availability of certain FOQA program data to certificating authorities, manufacturers and airport operators will contribute to improving the safety and efficiency of design and operations of air traffic control systems, aircraft and airports.

Scores of potential applications of the information gathered from FOQA programs have been identified and range from safety considerations to evaluating training practices, operating procedures, aircraft engineering and maintenance, and aircraft design considerations. Several foreign air carriers have successfully implemented programs for utilizing Digital Flight Data Recorder (DFDR) data in a FOQA-type program for operational safety and performance improvements. Long track records in making effective use of this information, 20 years in the case of British Airways, have provided the foreign carriers with clear evidence that FOQA information represents a new source of valuable information that can contribute greatly to aviation safety when appropriately utilized. Airlines that currently have FOQA-type programs agree that insights derived from these programs have prevented serious incidents and accidents and have led to improved operating efficiencies. Manufacturers of large jet transports have also endorsed FOQA as a means of enhancing safety by improving operating procedures and crew training and aircraft design, especially in the human-machine interface. However, DFDR information has only been used by domestic carriers on a limited basis and not as part of a comprehensive, long-term program such as that developed and evolved by the foreign carriers.

A FOQA program also helps to identify and correct deficiencies in flight crew training and operating procedures. Other safety objectives include development of an automated industry safety data base and improved training information based on incident analysis and indicators of the level of safety. Inter-airline sharing of FOQA trend information will support these improvements.

A key joint industry-government recommendation from the DOT Aviation Safety Conference (January, 1995) is that the FAA take action to encourage and facilitate the voluntary implementation of FOQA programs by U.S. airlines, and in particular, that the FAA sponsor a FOQA demonstration study to provide a sound basis for developing guidelines in this area. To encourage the development of a voluntary FOQA program for safety enhancement, the FAA Administrator issued a letter, dated 9 February 1995, that was jointly addressed to the Presidents of the Air Transport Association and the Air Line Pilots Association. The Administrator's letter stipulates that the FAA will not use airline gathered FOQA data for enforcement purposes against airlines or their employees. The letter further acknowledges that airlines will **not** be required to submit FOQA data to the FAA. The letter also commits the FAA to initiate a two year FOQA demonstration study to be conducted in partnership with the airlines in fiscal year 1995.

Other relevant FAA publications include:

a. AC 120-59 Air Carrier Internal Evaluation Programs;
b. Air Carrier Internal Evaluation-Model Program Guide;
c. AC 120-56 Air Carrier Voluntary Disclosure Reporting Procedures;
d. AC 120-54 Advanced Qualification Program (AQP); and
e. AC 00-46C Aviation Safety Reporting Program (ASRP).

Information derived from FOQA programs can be included in the voluntary audits and evaluations described in AC 120-59 to determine the causes of deficiencies and suggest enhancements to operating practices. Air carriers can avoid FAA penalty actions by reporting apparent violations identified by FOQA programs by using the procedures outlined in AC

120-56. Carriers operating under the Advanced Qualification Program (AQP) [defined in Special FAR No. 58 and AC 120-54] provide the FAA de-identified crew performance data and trend information collected during flight crew training as part of AQP validation. The FAA uses the performance information to establish group performance norms and it may also use the data to ensure that AQP changes reduce of accident and incident rates. Certificate holders operating under SFAR No. 58 may use FOQA data in addition to training data to support AQP validation.

The primary system components that are utilized in FOQA programs include:

1. Airborne data-recording equipment that acquires and captures the necessary in-flight information and
2. Ground-based analysis stations that process the digital flight recorder data, determine what exceedances were detected in the flight, transform the data into the appropriate format for analysis, and generate various reports and visualizations to assist airline personnel in interpreting the exceedances.

The ground-based analysis stations produce information on any detected exceedances that represent deviations from normal operating envelopes or exceptional conditions. The flight data analysis component of the ground-based station categorizes operational events to be flagged by defining a set of parameters that indicate normal operating envelopes. Those special events whose parameters deviate from these thresholds are categorized as "alerts" that indicate serious deviations and "detects" for minor deviations. Any flight that has been flagged for further consideration is first screened to validate the quality and integrity of the collected data and to filter out any marginal or transitory irregularities.

After this validation step, the remaining special events are analyzed to determine if subsequent processing should include trend analysis or the nature of the required action, e.g., immediate notification of engineering or maintenance personnel if any potential damage to the aircraft was identified; reviews to identify corrective measures; and/or crew feedback. This processing of special alert and detect events to determine if a significant event has occurred is performed manually by a human analyst. Reports are generated that provide information on the nature of the identified event, categorization and associated event parameters, and pertinent flight information. A variety of tools are provided by the various ground-based systems for the interpretation and visualization of identified special events including plots of flight profiles and event parameters. At the conclusion of the process, the data can be retained based upon airline established categorization with normal flights typically archived and those with identified alert and detect events stored in historical databases. The ground-based stations also include the capability to apply the appropriate protective procedures needed to prevent misuses of data and/or reports, such as de-identification of pilot and specific flight information. Some ground-based systems also include trend analysis capabilities that use historical databases to identify similar deviations in the past to determine if any patterns exist and should be further explored.

The parameters for detecting exceedances are based upon those provided by the data capturing, recording, and storage capabilities of the DFDR. The associated thresholds for these parameters vary by the type of aircraft and associated operating limits, standard operating procedures, phase of flight, and duration of any irregularity. For example, the threshold of selected parameters may be defined for various altitudes, e.g., 1,000, 500, 250, and 100 feet, during landing mode events. Additional information used in the analysis includes general parameters about the aircraft type and historical information used for trend analysis. Currently, about 40 to 50 event categories are typically defined based on a strategy of identifying those that would have the greatest potential for safety and performance considerations. Approximately 30 to 40 parameters are assessed for these events for various phases of flights and aircraft types. The event categories and associated parameters have evolved in a trial and error process using empirical flight data and are subject to an ongoing evaluation and modification process.

2. INTRODUCTION

State goals and objectives of your airline's FOQA program. Boilerplate is provided as a starting point but should be modified as appropriate.

The specific objectives of a FOQA program developed by this airline are to:

a. Collect operational flight data to identify needed improvements in training programs, the ATC system, aircraft and airport design, and to evaluate and improve the performance of flight crews;

b. Compare the collected data with established procedures and standards to identify needed improvements, and to develop exceedance information;

c. Perform trend analyses of exceedances to evaluate corrective actions and measure performance over time; and,

d. Use analyzed data in formal awareness and feedback programs to enhance safety in the following areas:

    1. Flight procedures;

    2. Flight training procedures;

    3. Crew performance in all phases of flight;

    4. Air traffic control procedures;

    5. Flight crew-aircraft systems interface; and

    6. Aircraft and airport design and maintenance.

Summarize protective provisions to be incorporated into FOQA program to ensure acceptance by all participants, including pilot associations.

3. FOQA PROGRAM ELEMENTS

Describe the specific components to be used in the FOQA program

3.1 Airborne System

Describe the airborne system configuration and indicate the equipment to be installed in the aircraft; discuss maintenance policies for airborne system

3.2 Ground System

Describe the ground-based system to be utilized for the FOQA program including hardware and software

3.3 Other Equipment

Describe any other FOQA components such as downlink of data from aircraft to ground stations; trend analysis software, etc.

4.0 ORGANIZATION

Describe the organization and management of the FOQA program

Indicate the duties and responsibilities of personnel associated with the FOQA for administration; data collection and retrieval; data security and protection; data reduction and analysis; assessment of exceedances and trends; corrective actions and feedback; data trending; record retention, etc.

Describe committees/teams tasked for FOQA activities for such activities as technical advice; monitoring and evaluation of FOQA program and data; liaison with pilot associations; event reviews; .

4.1 FOQA Program

Describe the concept of the FOQA program at your airline including operational procedures for transfer of data from airborne systems to ground-based stations; evaluation of the ground-based station results; data reduction and analysis; assessment of results; determination of actions to be taken for identified events; feedback/follow-up for resolution; data trending.

4.1.1 Data Protection and Security

Describe the data use agreement with flight crew associations for individual protection and data use.

Describe methods for protecting the data. controlling access to data, assuring confidentiality; de-identification, crew contact; data access and control; and record retention; and data safeguards.

4.1.2 Event Classifications and Definitions

Define the categories/classifications to be used for events; describe the process for defining and maintaining events of interest and associated parameters. Provide in Appendix B event classification by operational mode.

4.1.3 Data Collection and Retrieval

Describe how FOQA data will be recorded (i.e., raw flight data vs record only exeedance data); transport of data from aircraft to ground station; logistics.

4.1.4 Data Reduction and Analysis

Describe how the recorded data will be transformed into format suitable analysis; data quality and integrity standards; classification and verification of events; etc.

4.1.5 Exceedance Review and Evaluation

Describe procedures for reviewing and evaluating event reports; reporting needs; notification of appropriate personnel, i.e., flight crews, engineering/maintenance departments, training, etc.; resolution of exceedances; determination of corrective actions; feedback loop; periodic summaries of events.

4.1.6 Data Trending and Record Retention

Describe procedures for maintaining information for trend analysis including databases; detection of trends; periodic reporting; .evaluation of identified trends; corrective actions; feedback.

4.1.7 Data Usage

Describe any other anticipated usage of FOQA data

GLOSSARY

Include definition of all acronyms used in document

ACMS	Aircraft Condition Monitoring System
AIDS	Aircraft Integrated Data System
AIMS	Aircraft Integrated Monitoring System
ATC	Air Traffic Control
DFDAU	Digital Flight Data Acquisition Unit
DFDR	Digital Flight Data Recorder
DMU	Data Management Unit
DRU	Data Recovery Unit
FDAU	Flight Data Acquisition Unit
FOQA	Flight Operational Quality Assurance
IEP	Internal Evaluation Program
OQAR	Optical Quick Access Recorder
QAR	Quick Access Recorder
STC	Supplemental Type Certificate
TC	Type Certificate

APPENDICES

Appendix A. Airline-Pilot Association Agreement

Appendix B. Exceedance Selections Charts

REFERENCES

Include citations for all referenced documents

Flight Safety Foundation, (1991). Air Carrier Voluntary Flight Operational Quality Assurance (FOQA) Program, FAA Contract Report, Draft. *(Available from the FAA Flight Standards Office and the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, (703) 487-4600)*